AD-A103 241 MITRE CORP MCLEAN VA F/G 1/2

FUTURE ATC SYSTEM DESCRIPTION ATC FACILITIES AND INTERFACES (19--ETC(U)

JAN 81 J H CHILDERS, R C HUNTER, D TUTTLE DOT-FA01-81-C-10001

UNCLASSIFIED MTR-81W6 FAA/RD-81/17 NL

1 OF 5

AD A103241

LEVEL II

DOT/FAA/RD-81/17
MTR-81W8

Future ATC System Description ATC Facilities and Interfaces (1980 - 1990)

12

AD A103241

James H. Childers,
Roger G. Hunter
Systems Research and
Development Service, FAA

David Tuttle
Airway Facilities
Service, FAA

R.A. Bales, P.O. Dodge,
W.F. Potter, T.R. Simpson,
A.J. Steger, M.E. Kay, J.S. Matney
The MITRE Corporation

January 1981

Final Report

U.S. Department of Transportation
Federal Aviation Administration
Systems Research & Development Service
Washington, D.C. 20590

NOTICE

12 463

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
18 11 DOT/FAA/RD-81/17	AD-A103241	11

4. Title and Subtitle	5. Report Date
Future ATC System Description ATC Facilities and Interfaces (1980-1990).	Jan[redacted]81
	6. Performing Organization Code
7. Author's 10 James H./Childers [redacted] Roger G./Hunter [redacted] [redacted] David/Tuttle [redacted] R.A./Bales	**8. Performing Organization Report No.** 14 MTR-81W8
9. Performing Organization Name and Address Systems Research and Devel[redacted] Airway Facilities Service The MITRE Company	**10. Work Unit No. (TRAIS)**
	11. Contract or Grant No. 15 DOT-[redacted] FA01-81-C-10001
12. Sponsoring Agency Name and Address Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D.C. 20591	**13. Type of Report and Period Covered** 9 Final Report,
	14. Sponsoring Agency Code ARD-400

15. Supplementary Notes

* R. A. Bales, P. O. Dodge, W. F. Potter, T. R. Simpson, A. J. Steger, M. E. Kay, J. S. Matney, (The Mitre Corp.)

16. Abstract

This report describes the evolution of the air traffic control system facilities in the pre-1990 time period as major system improvements currently being developed by the FAA are implemented. The description was prepared to assist FAA managers with the technical planning for the future air traffic control system. The description covers eight major domestic ATC facilities classifications: En Route, TRACON, Tower, ATC Command Center, Flight Service Stations, Surveillance, Navigation, and Communications. The report provides a summary description of each improvement currently being planned, describes the information flow between ATC facilities to support the improvement, and provides tentative implementation dates for each improvement. Where system configuration questions were encountered, an assumption about the final course of action was made and duly noted. These system integration issues identify questions that the FAA will be addressing prior to reaching implementation decisions and are reported more completely in another FAA document.

17. Key Words	18. Distribution Statement
Air Traffic Control, En Route ATC, TRACON, Tower Cab, ATC Command Center, Navigation, Surveillance, Communications	Document is available to the public through the National Technical Information Service, Springfield, Virginia, 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	349	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

402 261

PREFACE

This document was prepared to describe the ATC system as it would appear in two future time frames if on-going FAA programs aimed at improving the ATC system are successful and implemented. The objective was to make explicit the system interfaces implied by the current FAA program of planned ATC system improvements and to identify those interfaces that merit FAA planning attention. The actual system that may evolve in future years is likely to be different than the system described herein due to the open-ended and dynamic nature of the FAA R&D process. The document does not consider the logistical and budgetary constraints encountered in implementing major systems. Thus, this document should be viewed as an aid to the technical planning for system implementation. It does not necessarily reflect an FAA position on the ATC system that should be in place by a given time period or commit the FAA to implement the features described in this report.

ACKNOWLEDGEMENTS

This document is based on the assimilation of information from many sources. We wish to acknowledge the contributions of the following individuals and organizations whose efforts significantly enhanced the accuracy and timeliness of the document.

R. Brubaker	AAT
R. Cooper	AAT
H. Goldstein	AAF
G. Thompson	AAF
R. Wein	AAF
P. Neumann	AEM
L. Cusimano	AFO
K. Byram	APO
J. Hawkins	APO
E. Mandel	ARD
O. Osborne	ARD
L. Page	ARD
M. Pozesky	ARD
R. Tucker	ARD

And various other representatives of AAT, AAS, AAF, AEM, AFO, APO, APP, and ARD.

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1-1
1.1 Scope	1-2
1.2 Approach	1-3
1.2.1 ATC Facilities	1-4
1.2.2 Time Periods	1-4
1.2.3 Document Structure	1-11
2. EN ROUTE FACILITIES	2-1
2.1 En Route Facilities Improvements	2-3
2.1.1 En Route Data Processing Equipment	2-8
2.1.1.1 Current System	2-9
2.1.1.2 Near Term Improvements	2-10
2.1.1.3 Far Term Improvements	2-12
2.1.1.4 Potential and Longer Range Improvements	2-13
2.1.2 En Route Input/Output Equipment	2-15
2.1.2.1 Current System	2-16
2.1.2.2 Near Term Improvements	2-18
2.1.2.3 Far Term Improvements	2-20
2.1.2.4 Potential and Longer Range Improvements	2-23
2.1.3 Processing and Display of ATC and Related Data	2-25
2.1.3.1 Current System	2-26
2.1.3.2 Near Term Improvements	2-27
2.1.3.3 Far Term Improvements	2-27
2.1.3.4 Potential and Longer Range Improvements	2-29
2.1.4 Aircraft Separation Services	2-33
2.1.4.1 Current System	2-33
2.1.4.2 Near Term Improvements	2-33
2.1.4.3 Far Term Improvements	2-35
2.1.4.4 Potential and Longer Range Improvements	2-35
2.1.5 Communication with Aircraft	2-36

TABLE OF CONTENTS
(Continued)

	Page
2.1.5.1 Current System	2-36
2.1.5.2 Near Term Improvements	2-36
2.1.5.3 Far Term Improvements	2-37
2.1.5.4 Potential and Longer Range Improvements	2-37
2.1.6 Detection of Unsafe/Unacceptable Use of Airspace	2-37
2.1.6.1 Current System	2-37
2.1.6.2 Near Term Improvements	2-38
2.1.6.3 Far Term Improvements	2-38
2.1.6.4 Potential and Longer Range Improvements	2-38
2.1.7 Traffic Flow Management	2-39
2.1.7.1 Current System	2-41
2.1.7.2 Near Term Improvemens	2-42
2.1.7.3 Far Term Improvements	2-43
2.1.7.4 Potential and Longer Range Improvements	2-44
2.2 En Route Facilities Connectivity	2-44
2.3 En Route Facilities Tentative Implementation Schedule	2-53
2.4 En Route Facilities Interface Planning Summary	2-53
2.4.1 Assumptions in Regard to DABS, ATARS, and Data Link	2-55
2.4.2 Assumptions in Regard to Other Issues	2-57
3. TRACON FACILITIES	3-1
3.1 TRACON Facilities Improvements Summary	3-6
3.1.1 Terminal Data Processing Equipment	3-12
3.1.1.1 Current System	3-12
3.1.1.2 Near Term Improvements	3-14
3.1.1.3 Far Term Improvements	3-15
3.1.1.4 Potential and Longer Range Improvements	3-18
3.1.2 Terminal Input/Output Equipment	3-20
3.1.2.1 Current System	3-21

TABLE OF CONTENTS
(Continued)

	Page
3.1.2.2 Near Term Improvements	3-22
3.1.2.3 Far Term Improvements	3-23
3.1.2.4 Potential and Longer Range Improvements	3-24
3.1.3 Processing and Display of Aircraft and Weather Data	3-25
3.1.3.1 Current System	3-25
3.1.3.2 Near Term Improvements	3-27
3.1.3.3 Far Term Improvements	3-27
3.1.3.4 Potential and Longer Range Improvements	3-30
3.1.4 Aircraft Separation Services	3-31
3.1.4.1 Current System	3-33
3.1.4.2 Near Term Improvements	3-34
3.1.4.3 Far Term Improvements	3-36
3.1.4.4 Potential and Longer Range Improvements	3-40
3.1.5 Communication with Aircraft	3-41
3.1.5.1 Current System	3-41
3.1.5.2 Near Term Improvements	3-42
3.1.5.3 Far Term Improvements	3-42
3.1.5.4 Potential and Longer Range Improvements	3-43
3.1.6 Detection of Unsafe/Unacceptable Use of Airspace	3-43
3.1.6.1 Current System	3-43
3.1.6.2 Near Term Improvements	3-45
3.1.6.3 Far Term Improvements	3-45
3.1.6.4 Potential and Longer Range Improvements	3-46
3.1.7 Traffic Flow Management	3-47
3.1.7.1 Current System	3-47
3.1.7.2 Near Term Improvements	3-47
3.1.7.3 Far Term Improvements	3-47
3.1.7.4 Potential and Longer Range Improvements	3-51
3.2 TRACON Facilities Connectivity	3-51

TABLE OF CONTENTS
(Continued)

	Page
3.3 TRACON Facilities Tentative Implementation Schedule	3-60
3.4 TRACON Facilities Interface Planning Summary	3-62
3.4.1 DABS-Related ARTS Software Issues	3-63
3.4.2 DABS-Related Hardware Issues	3-64
3.4.3 ARTS Software Issues	3-65
3.4.4 Terminal Hardware Issue	3-66
3.4.5 Miscellaneous Issues	3-66
4. TOWER FACILITIES	4-1
4.1 Tower Cab Improvements	4-1
4.1.1 Current Tower Cab Functions	4-3
4.1.2 Near Term Tower Cab Improvements	4-7
4.1.3 Far Term Tower Cab Improvements	4-13
4.1.4 Potential and Longer Range Tower Cab Improvements	4-16
4.2 Tower Cab System Connectivity	4-18
4.3 Tower Cab Improvements Tentative Implementation Schedule	4-26
4.4 Tower Facilities Interface Planning Summary	4-26
5. AIR TRAFFIC CONTROL COMMAND CENTER	5-1
5.1 ATCCC Improvements	5-2
5.1.1 Central Flow Control Function	5-5
5.1.1.1 Current System	5-5
5.1.1.2 Near Term Improvements	5-13
5.1.1.3 Potential and Longer Range Improvements	5-15
5.1.2 Central Flow Weather Service Unit	5-16
5.1.3 Airport Reservation Office	5-18
5.1.4 Central Altitude Reservation Function	5-19
5.1.5 Contingency Command Post	5-20
5.2 ATCCC System Connectivity	5-21
5.3 ATCCC Tentative Implementation Schedule	5-24
5.4 ATCCC Facility Interface Planning Summary	5-24

<u>TABLE OF CONTENTS</u>
<u>(Continued)</u>

	Page
6. FLIGHT SERVICE FACILITIES	6-1
6.1 Flight Service Facilities Improvements	6-7
6.1.1 Emergency Assistance	6-17
6.1.2 En Route Flight Advisory Service (EFAS)	6-19
6.1.3 Data Base Maintenance	6-20
6.1.3.1 Aviation Weather Processor	6-21
6.1.3.2 FSDPSs	6-22
6.1.4 NOTAM Processing	6-22
6.1.5 Preparation of PATWAS/TWEB	6-23
6.1.6 Specialist Weather Briefing	6-24
6.1.7 Specialist Flight Plan Processing	6-27
6.1.8 Weather Observations	6-28
6.1.9 PATWAS/TWEB Access	6-28
6.1.10 Pilot Flight Plan Entry/Close	6-29
6.1.11 Pilot Weather Briefing	6-29
6.1.12 Improvements Dependencies	6-30
6.1.13 Potential and Longer Range Improvements	6-31
6.2 Flight Service Facilities Connectivity	6-31
6.2.1 National Weather Service	6-39
6.2.2 Satellite Field Service Station	6-39
6.2.3 Weather Message Switching Center	6-39
6.2.4 Aviation Weather Processor	6-43
6.2.5 Air Traffic Control Command Center (ATCCC)	6-43
6.2.6 Air Route Traffic Control Center (ARTCC)	6-43
6.2.7 Pilot	6-44
6.2.8 Tower Cab	6-44
6.2.9 Weather Radar Surveillance Site	6-45
6.3 Flight Service Facilities Tentative Implementation Schedule	6-45
6.4 Flight Service Interface Planning Summary	6-47
7. SURVEILLANCE FACILITIES	7-1
7.1 En Route Surveillance Sites	7-2
7.1.1 Current En Route Surveillance Site Functions	7-2

TABLE OF CONTENTS
(Continued)

	Page
7.1.2 Near Term En Route Surveillance Site Improvements	7-4
7.1.3 Far Term En Route Surveillance Site Improvements	7-9
7.1.4 Potential and Longer Range Improvements for En Route Surveillance Sites	7-12
7.1.5 En Route Surveillance Site System Connectivity	7-12
7.1.6 En Route Surveillance Improvements Tentative Implementation Schedule	7-13
7.2 Terminal Surveillance Sites	7-18
7.2.1 Current Terminal Surveillance Site Functions	7-18
7.2.2 Near Term Terminal Surveillance Site Improvements	7-20
7.2.3 Far Term Terminal Surveillance Site Improvements	7-25
7.2.4 Potential and Longer Range Improvements for Terminal Surveillance Sites	7-30
7.2.5 Terminal Surveillance Site System Connectivity	7-30
7.2.6 Terminal Surveillance Improvements Tentative Implementation Schedule	7-36
7.3 Surveillance Facilities Interface Planning Summary	7-36
8. NAVIGATION FACILITIES	8-1
8.1 Navigation Facilities Improvements	8-1
8.1.1 En Route and Terminal Area Navigation Facilities	8-3
8.1.1.1 FAA Navigation Facilities	8-3
8.1.1.2 Non-FAA Navigation Facilities	8-7
8.1.2 Approach and Landing Navigation Facilities	8-8
8.1.2.1 Precision Instrument Approaches	8-8
8.1.2.2 Non-Precision Instrument Approaches	8-13
8.1.2.3 Approaches by VFR Aircraft	8-14
8.1.2.4 Approach and Landing Navigation Facilities Improvements	8-15
8.1.2.5 Associated Improvements	8-16
8.2 Navigation Facilities System Connectivity	8-17

TABLE OF CONTENTS
(Continued)

		Page
	8.3 Navigation Improvements Tentative Implementation Schedule	8-22
	8.4 Navigation Facilities Interface Planning Summary	8-24
9.	COMMUNICATIONS FACILITIES	9-1
	9.1 Data Communications	9-2
	9.1.1 Improvements and Connectivity	9-3
	9.1.1.1 En Route Facilities Improvements	9-3
	9.1.1.2 TRACON/Tower Facilities Improvements	9-27
	9.1.1.3 ATCCC Improvements	9-42
	9.1.1.4 Flight Service Facility Improvements	9-51
	9.1.2 Data Communications Networks	9-67
	9.1.2.1 Current Data Communications Network	9-67
	9.1.2.2 National Airspace Data Interchange Network (NADIN)	9-74
	9.1.3 Tentative Data Communications Implementation Schedule	9-81
	9.1.4 Data Communications Facilities Interface Planning Summary	9-88
	9.2 Voice Communications	9-89
	9.2.1 Voice Communications Improvements Summary	9-90
	9.2.1.1 En Route Improvements	9-90
	9.2.1.2 TRACON/Tower Improvements	9-95
	9.2.1.3 FSS Improvements	9-98
	9.2.2 Voice Communications Connectivity	9-102
	9.2.3 Voice Communications Tentative Implementation Schedule	9-109
	9.2.4 Voice Communications Facilities Interface Planning Summary	9-109

TABLE OF CONTENTS
(Concluded)

	Page
APPENDIX A: SOURCE DOCUMENTS	A-1
APPENDIX B: ABBREVIATIONS AND ACRONYMS	B-1
APPENDIX C: INDEX OF ATC SYSTEM IMPROVEMENTS	C-1

LIST OF ILLUSTRATIONS

		Page
TABLE 1-1:	ATC SYSTEM FACILITIES	1-5
TABLE 1-2:	SUMMARY OF ATC SYSTEM IMPROVEMENTS	1-7
TABLE 1-3:	INDEX OF SYSTEM INTEGRATION ISSUES	1-14
TABLE 2-1:	EN ROUTE FACILITIES IMPROVEMENTS SUMMARY	2-4
TABLE 3-1:	FEATURES OF TERMINAL AUTOMATION SYSTEMS	3-3
TABLE 3-2:	TERMINAL ATC FACILITIES	3-4
TABLE 3-3:	ARTS III AND ARTS IIIA FACILITIES IMPROVEMENTS SUMMARY	3-7
TABLE 3-4:	ARTS II, ARTS IIA, AND TPX-42 FACILITIES IMPROVEMENTS SUMMARY	3-8
TABLE 4-1:	CURRENT TERMINAL ATC FACILITIES	4-2
TABLE 4-2:	CURRENT TOWER CAB FUNCTIONS AND EQUIPMENT	4-4
TABLE 4-3:	TOWER CAB IMPROVEMENTS SUMMARY	4-8
TABLE 5-1:	ATCCC FACILITY IMPROVEMENTS SUMMARY	5-3
TABLE 5-2:	CENTRAL FLOW CONTROL FUNCTION IMPROVEMENT SUMMARY	5-4
TABLE 6-1:	FLIGHT SERVICE FACILITIES IMPROVEMENTS SUMMARY	6-11
TABLE 6-2:	WEATHER AND AERONAUTICAL INFORMATION CATEGORIES	6-25
TABLE 7-1:	CURRENT EN ROUTE SURVEILLANCE SITE FUNCTIONS AND EQUIPMENT	7-3
TABLE 7-2:	EN ROUTE SURVEILLANCE SITE IMPROVEMENTS SUMMARY	7-5
TABLE 7-3:	CURRENT TERMINAL SURVEILLANCE SITE FUNCTIONS AND EQUIPMENT	7-19

LIST OF ILLUSTRATIONS
(Continued)

		Page
TABLE 7-4:	TERMINAL SURVEILLANCE SITE IMPROVEMENTS SUMMARY	7-21
TABLE 8-1:	NAVIGATION FACILITIES IMPROVEMENTS	8-2
TABLE 8-2:	VORTAC FUNCTIONS AND EQUIPMENT	8-5
TABLE 8-3:	CURRENT FAA EN ROUTE AND TERMINAL AREA NAVIGATION GROUND SITES	8-5
TABLE 8-4:	CURRENT APPROACH AND LANDING NAVIGATION FACILITIES FUNCTIONS AND EQUIPMENT	8-9
TABLE 8-5:	CURRENT AND PLANNED ILS DEPLOYMENT	8-11
TABLE 8-6:	PRECISION INSTRUMENT APPROACH CATEGORIES	8-11
TABLE 8-7:	TYPES OF MLS SYSTEMS	8-21
TABLE 9-1:	ASSUMPTIONS FOR EN ROUTE FACILITIES DATA COMMUNICATIONS	9-4
TABLE 9-2:	EN ROUTE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY	9-6
TABLE 9-3:	ASSUMPTIONS FOR TRACON/TOWER FACILITIES DATA COMMUNICATIONS	9-28
TABLE 9-4:	TRACON/TOWER FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY	9-29
TABLE 9-5:	ASSUMPTIONS FOR ATCCC FACILITY DATA COMMUNI-CATIONS	9-44
TABLE 9-6:	ATCCC FACILITY - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY	9-45
TABLE 9-7:	ASSUMPTIONS FOR FLIGHT SERVICE FACILITIES DATA COMMUNICATIONS	9-52
TABLE 9-8:	WEATHER AND FLIGHT SERVICE FACILITIES - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY	9-53

LIST OF ILLUSTRATIONS
(Continued)

		Page
TABLE 9-9:	TRAFFIC HANDLED BY NADIN	9-79
TABLE 9-10:	EN ROUTE FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY	9-91
TABLE 9-11:	TERMINAL FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY	9-96
TABLE 9-12:	FLIGHT SERVICE FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY	9-100
FIGURE 2-1:	CURRENT EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM	2-5
FIGURE 2-2:	NEAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM	2-6
FIGURE 2-3:	FAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM	2-7
FIGURE 2-4:	CURRENT ARTCC CONNECTIVITY DIAGRAM	2-45
FIGURE 2-5:	NEAR TERM ARTCC CONNECTIVITY DIAGRAM	2-47
FIGURE 2-6:	FAR TERM ARTCC CONNECTIVITY DIAGRAM	2-49
FIGURE 2-7:	EN ROUTE FACILITIES -- ARTCC, TENTATIVE IMPLEMENTATION SCHEDULE	2-54
FIGURE 3-1:	CURRENT TRACON FACILITIES (ARTS III) INFORMATION FLOW DIAGRAM	3-9
FIGURE 3-2:	NEAR TERM TRACON FACILITIES (ARTS IIIA) INFORMATION FLOW DIAGRAM	3-10
FIGURE 3-3:	FAR TERM TRACON FACILITIES (ARTS IIIA) INFORMATION FLOW DIAGRAM	3-11
FIGURE 3-4:	CURRENT TRACON (ARTS III) CONNECTIVITY DIAGRAM	3-53

LIST OF ILLUSTRATIONS
(Continued)

		Page
FIGURE 3-5:	NEAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM	3-55
FIGURE 3-6:	FAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM	3-57
FIGURE 3-7:	TRACON FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	3-61
FIGURE 4-1:	CURRENT TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS) FUNCTIONAL INFORMATION FLOW DIAGRAM	4-9
FIGURE 4-2:	NEAR TERM TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS) FUNCTIONAL INFORMATION FLOW DIAGRAM	4-10
FIGURE 4-3:	FAR TERM TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS) FUNCTIONAL INFORMATION FLOW DIAGRAM	4-11
FIGURE 4-4:	CURRENT TOWER CAB CONNECTIVITY DIAGRAM (HIGH IFR ACTIVITY AIRPORT)	4-19
FIGURE 4-5:	NEAR TERM TOWER CAB CONNECTIVITY DIAGRAM (HIGH IFR ACTIVITY AIRPORT)	4-21
FIGURE 4-6:	FAR TERM TOWER CAB CONNECTIVITY DIAGRAM (HIGH IFR ACTIVITY AIRPORT)	4-23
FIGURE 4-7:	TOWER FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	4-27
FIGURE 5-1:	CURRENT AIR TRAFFIC CONTROL SYSTEM COMMAND CENTER INFORMATION FLOW DIAGRAM	5-6
FIGURE 5-2:	NEAR TERM AIR TRAFFIC CONTROL COMMAND CENTER INFORMATION FLOW DIAGRAM	5-7
FIGURE 5-3:	CURRENT CENTRAL FLOW CONTROL COMMUNICATIONS NETWORK	5-10
FIGURE 5-4:	CURRENT ATCCC CONNECTIVITY DIAGRAM	5-22

LIST OF ILLUSTRATIONS
(Continued)

		Page
FIGURE 5-5:	NEAR TERM ATCCC CONNECTIVITY DIAGRAM	5-23
FIGURE 5-6:	ATCCC FACILITY TENTATIVE IMPLEMENTATION SCHEDULE	5-25
FIGURE 6-1:	NON-AUTOMATED FSS LOCATIONS	6-2
FIGURE 6-2:	MODEL 1 FLIGHT SERVICE AUTOMATION	6-3
FIGURE 6-3:	MODEL 1 FACILITY LOCATIONS	6-5
FIGURE 6-4:	MODEL 2 FLIGHT SERVICE FACILITIES	6-6
FIGURE 6-5:	MODEL 2 FLIGHT SERVICE FACILITY LOCATIONS	6-8
FIGURE 6-6:	CURRENT FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM	6-13
FIGURE 6-7:	NEAR TERM (MODEL 1) FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM	6-14
FIGURE 6-8:	NEAR TERM (MODEL 2) FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM	6-15
FIGURE 6-9:	FAR TERM FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM	6-16
FIGURE 6-10:	CURRENT FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM	6-33
FIGURE 6-11:	NEAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM (MODEL 1)	6-35
FIGURE 6-12:	NEAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM (MODEL 2)	6-37
FIGURE 6-13:	FAR TERM FLIGHT SERVICE CONNECTIVITY DIAGRAM	6-41
FIGURE 6-14:	FLIGHT SERVICE FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	6-46

LIST OF ILLUSTRATIONS
(Continued)

		Page
FIGURE 7-1:	CURRENT EN ROUTE SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-6
FIGURE 7-2:	NEAR TERM EN ROUTE SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-7
FIGURE 7-3:	FAR TERM EN ROUTE SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-8
FIGURE 7-4:	CURRENT EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-14
FIGURE 7-5:	NEAR TERM EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-15
FIGURE 7-6:	FAR TERM EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-16
FIGURE 7-7:	EN ROUTE SURVEILLANCE FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	7-17
FIGURE 7-8:	CURRENT TERMINAL SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-22
FIGURE 7-9:	NEAR TERM TERMINAL SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-23
FIGURE 7-10:	FAR TERM TERMINAL SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM	7-24
FIGURE 7-11:	CURRENT TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-31
FIGURE 7-12:	NEAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-32
FIGURE 7-13:	FAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM	7-33
FIGURE 7-14:	TERMINAL SURVEILLANCE FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	7-37

LIST OF ILLUSTRATIONS
(Continued)

		Page
FIGURE 8-1:	NAVIGATION FACILITIES CONNECTIVITY DIAGRAM	8-18
FIGURE 8-2:	NAVIGATION FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	8-23
FIGURE 9-1:	CURRENT EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-15
FIGURE 9-2:	NEAR TERM EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-17
FIGURE 9-3:	FAR TERM EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-19
FIGURE 9-4:	CURRENT TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-37
FIGURE 9-5:	NEAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-38
FIGURE 9-6:	FAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-39
FIGURE 9-7:	CURRENT ATCCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-48
FIGURE 9-8:	NEAR TERM ATCCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-49
FIGURE 9-9:	CURRENT FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-60
FIGURE 9-10:	NEAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-61
FIGURE 9-11:	FAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM	9-62
FIGURE 9-12:	CURRENT DATA COMMUNICATIONS	9-69
FIGURE 9-13:	INITIAL NADIN CONFIGURATIONS	9-77

LIST OF ILLUSTRATIONS (Concluded)

	Page
FIGURE 9-14: NADIN SUBSYSTEM FUNCTIONS	9-78
FIGURE 9-15: NEAR TERM DATA COMMUNICATIONS	9-83
FIGURE 9-16: FAR TERM DATA COMMUNICATIONS	9-85
FIGURE 9-17: NADIN IMPLEMENTATION SCHEDULE	9-87
FIGURE 9-18: CURRENT VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM	9-103
FIGURE 9-19: NEAR TERM VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM	9-105
FIGURE 9-20: FAR TERM VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM	9-107
FIGURE 9-21: VOICE COMMUNICATIONS FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE	9-110

1. INTRODUCTION

The purpose of this document is to present a current overview of the FAA's planned improvements to the United States air traffic control (ATC) system and its associated interfaces. The presentation is directed not toward technical personnel interested in the design details of proposed improvements but to program managers and other management personnel who are interested in defining and assuring the adequacy of the interfaces between existing and new system elements.

The objectives behind the preparation of this document were to:

- Describe the CONUS ATC system after current major FAA engineering and development (AED) and operating service (AAT and AAF) program products are developed and integrated into the operational system.

- Identify and describe the interfaces that will have to be provided between system elements.

- Identify design configuration and time phasing concerns that require decisions by FAA managers.

The material presented in this document reflects the progress of engineering and implementation activities of the FAA over the last several years. This document represents a revision and expansion of an earlier document that described system development status and plans as of mid-1978 (Reference 1-1). The current document was prepared by the MITRE Corporation for the FAA's Systems Research and Development Service, Systems

Development Division (ARD-440) and represents system status and plans as of the end of calendar year 1980. This document was prepared as an integral part of the FAA's systems integration activity. The integration activity includes the integration of FAA system development and system acquisition plans, planning for long range engineering and development budgets, and tracking and resolution of system integration design issues. These other activities are reported separately by the FAA.

1.1 Scope

The scope of this project was limited to those systems that were directly involved with the provision of ATC services. Systems associated with purely administrative functions internal to the FAA were not addressed. The set of improvements to be addressed was restricted to those Facilities and Equipment (F&E) and Engineering and Development (E&D) products that are currently targeted for implementation and whose development cycle had progressed to the point where their interfaces could be reasonably well defined. Programs that were in the early stages of development or were being pursued on a feasibility basis, such as the Cockpit Display of Traffic Information (CDTI), were not considered in detail, but their potential system functions were briefly defined where appropriate.

This description of the ATC system addresses those transitions that are expected to occur from 1980 until the major en route ATC computer system is replaced in the late 1980s. Modifications of system interfaces that would be associated with this computer replacement have not yet been defined and are not included in this document.

The system functions and interfaces described in the document are based on normal mode operations. Failure or maintenance mode operations are not addressed. Some remote maintenance and monitoring features that are integral to some system improvements are discussed, however.

It should be noted that this document was intended to serve as an internal management and planning tool for the FAA. As such, it has attempted to reflect the current FAA management thinking as to proper system designs, configurations and implementation schedules. No attempt was made to justify these decisions or to examine alternative courses of actions from a technical, cost, or benefit basis.

1.2 Approach

To meet the stated objective, strawman future ATC system descriptions were prepared for two different future time frames to illustrate the expected ATC system configurations if current FAA system improvement plans were realized. These descriptions were facility oriented and focused on the technical operation of the hardware, software, and sensors used by ATC personnel to deliver new or improved services.

The resultant description contained in this document shows how the particular ATC facilities could be connected to other parts of the system and how these facilities and their associated connections are expected to change over time. Features that do not change are deemphasized.

1.2.1 ATC Facilities

For this study the ATC system was subdivided into facilities as noted in Table 1-1. The grouping of facilities falls along rather natural lines with some arbitrary assignments being made for some services. For example, the flight plan data distribution system for Terminal Radar and Approach Control (TRACON) and towers was primarily treated in the TRACON Facility chapter as the TRACON is generally a user of the current Flight Data Entry and Printout (FDEP) equipment and is projected to be a user in the future of Flight Data Input Output (FDIO) equipment and Terminal Information Display System (TIDS) equipment, although tower facilities may also use this equipment. Also, ATC services, such as separation assurance that use features that reside in a number of facilities were discussed in several chapters of the document. For example, the Automated Traffic Advisory and Resolution Service (ATARS) was described in the En Route, TRACON, and Surveillance chapters.

1.2.2 Time Periods

Facility descriptions were prepared for three time periods: Current, Near Term, and Far Term. The "Current" system was defined as consisting of those systems that were in operational use at some sites prior to the end of CY 1980. The Current system is the reference point for examining system changes and is presented only to a level of detail necessary to highlight system changes. This description is incomplete in most cases and is not intended as a tutorial on features of the present system.

TABLE 1-1
ATC SYSTEM FACILITIES

Chapter	Facilities	Primary Operational Services Provided
2. En Route Facilities	ARTCC	En Route ATC control and flight data handling of IFR flights
3. TRACON Facilities	ARTS IIIA, ARTS III, ARTS II, TPX-42	Terminal ATC control of IFR and VFR arrivals, departures, and overflights
4. Tower Facilities	Tower Cabs, electronic ground traffic surveillance, wind shear and wake vortex monitoring	Airport ATC control of IFR and VFR landings, takeoffs, and ground traffic
5. ATC Command Center	ATC Command Center in Washington D.C. and Jacksonville, Florida, Central Flow Control Computer Complex	Central IFR traffic flow management and central ATC emergency command center
6. Flight Service Facilities	FSS, Automated FSS, Flight Service Data Processing System, Aviation Weather Processor	Preflight and inflight weather briefing, VFR flight plan filing and monitoring, IFR flight plan filing, emergency location and search coordination services, weather and flight condition data acquisition and dissemination.
7. Surveillance Facilities	Search Radar, ATCRBS, DABS, NEXRAD weather radar	Electronic surveillance of airborne aircraft via primary and secondary radar and radar surveillance of weather
8. Navigation Facilities	VOR/DME, TACAN, RNAV, ILS, MLS, NDB	Electronic guidance for en route, terminal and landing operations
9. Communications Facilities	FAA voice and data input, output, switching, signaling, transmission, receiving and distribution facilities	Voice and data communications linking the facilities cited above -- ground/ground and ground/air/ground

The "Near Term" system was defined as the Current system modified to include those system improvements that could, according to present plans, be in operational use at some sites by the end of CY 1984. Many of the anticipated Near Term improvements have already been approved for implementation and some have active procurement contracts. System improvements that have been approved for implementation were noted in the documentation.

The "Far Term" system was defined as the "Near Term" system modified to include implementation of those additional system improvements expected to be in operational use at some sites prior to the implementation of the en route ATC computer replacement which is expected in the 1988-1990 time frame. This post-1984 Far Term system is somewhat tentative because of the additions, deletions, and modifications that naturally occur in a dynamic research and development program.

Another category of improvements, referred to as "Potential and Longer Range" improvements are also briefly described in the document. These improvements have not yet been targeted for implementation, awaiting results of preliminary development phases or awaiting the additional automation base to be provided by the expansion of en route or terminal ATC computer systems. It should be noted that some of the improvements in this category could be implemented at an earlier time period depending on changes in technical feasibility or operational need.

The system improvements to be described in this document are listed in Table 1-2.

TABLE 1-2
SUMMARY OF ATC SYSTEM IMPROVEMENTS

FACILITY	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
ARTCC	• EN ROUTE METERING* • DIRECT ACCESS RADAR CHANNEL (DARC) ENHANCEMENTS • IFR/VFR CONFLICT ADVISORY • REMOTE MAINTENANCE MONITOR SYSTEM (RMMS) FOR RCAGs & VORTACs* • FLIGHT STRIP PRINTER (FSP) REPLACEMENT WITH FLIGHT DATA INPUT OUTPUT EQUIPMENT (FDIO)* • EN ROUTE WEATHER DISPLAY SYSTEM (EWEDS)* • CONFLICT RESOLUTION ADVISORY	• ELECTRONIC TABULAR DISPLAY SUBSYSTEM (ETABS) • DISCRETE ADDRESS BEACON SYSTEM AUTOMATIC TRAFFIC ADVISORY AND RESOLUTION SERVICE (DABS/ATARS) FROM SELECTED TERMINAL SURVEILLANCE SITES • CENTER WEATHER SERVICE UNIT (CWSU) ENHANCEMENTS • EN ROUTE METERING ENHANCEMENTS • RMMS FOR EN ROUTE SURVEILLANCE SITES	• 9020 REPLACEMENT • AUTOMATED EN ROUTE AIR TRAFFIC CONTROL (AERA) • CONTROLLER SECTOR SUITE IMPROVEMENTS • DISCRETE ADDRESS BEACON SYSTEM AUTOMATIC TRAFFIC ADVISORY AND RESOLUTION SERVICE (DABS/ATARS) FROM EN ROUTE SURVEILLANCE SITES • DABS DATA LINK AVAILABLE • CONTROL MESSAGE AUTOMATION (CMA) • APPLICATIONS PROCESSOR FOR DABS DATA LINK • CENTER WEATHER PROCESSING COMPLEX
TRACON	• ARTS IIIA* • ACTIVE BEACON COLLISION AVOIDANCE SYSTEM (BCAS-ACTIVE AND RADAR BEACON TRANSPONDER FOR BCAS (RBX)) • FLIGHT DATA ENTRY AND PRINTOUT (FDEP) REPLACEMENT WITH FLIGHT DATA INPUT AND OUTPUT EQUIPMENT (FDIO)* • TPX-42 REPLACED BY ARTS II LIKE EQUIPMENT	• DABS/ATARS • DABS DATA LINK AVAILABLE • TERMINAL SEQUENCING & SPACING (TS&S) • TERMINAL INFORMATION DISPLAY SYSTEM (TIDS) • DISPLAY OF DIGITIZED SEARCH RADAR AND BEACON TARGET REPORTS • DISPLAY OF ADDITIONAL DIGITIZED WEATHER DATA (TURBULENCE & WIND SHEAR) • ARTS II ENHANCEMENTS (ARTS IIA) • FULL DIGITAL ARTS DISPLAY (FDAD) • CONTROL MESSAGE AUTOMATION (CMA)	• ARTS COMPUTER REPLACEMENT • FULL BEACON COLLISION AVOIDANCE SYSTEM (BCAS-FULL) • APPLICATIOANS PROCESSOR FOR DABS DATA LINK • TRACON WEATHER PROCESSING FUNCTION

* APPROVED BY THE FAA FOR IMPLEMENTATION

TABLE 1-2
(CONTINUED)

FACILITY	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
TOWER	• TOWER CAB DIGITAL DISPLAY (TCDD) • FLIGHT DATA ENTRY AND PRINTOUT (FDEP) EQUIPMENT REPLACEMENT WITH FLIGHT DATA INPUT OUTPUT EQUIPMENT (FDIO)* • AIRBORNE WIND SHEAR SYSTEM (AWSS) • TERMINAL DATA DISPLAY SYSTEM (TDDS) • WIND AND ALTIMETER VOICE EQUIPMENT (WAVE) • COMPUTER GENERATED AUTOMATIC TERMINAL INFORMATION SERVICE (CGATIS)	• AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3) • TERMINAL INFORMATION DISPLAY SYSTEM (TIDS) • NEXT GENERATION WEATHER RADAR (NEXRAD) • JOINT AUTOMATIC WEATHER OBSERVATION SYSTEM (JAWOS) • ENHANCED TERMINAL INFORMATION SERVICE (ETIS)	• ADVANCED VORTEX SYSTEM (AVS) • AUTOMATED AIRPORT ADVISORY SYSTEM (AAAS) • TOWER AUTOMATED GROUND SURVEILLANCE (TAGS) • DABS DATA LINK (TAKE OFF CLEARANCE, CLEARANCE DELIVERY) • RUNWAY CONFIGURATION MANAGEMENT SYSTEM (RCMS) • FAA TERMINAL WEATHER RADAR
ATCCC (ATC COMMAND CENTER)	• COMMUNICATIONS PROCESSOR AT JACKSONVILLE* • AUTOMATION FOR CENTRAL ALTITUDE *RESERVATION FUNCTION (CARF)* AND AIRPORT RESERVATION OFFICE (ARO)* • CENTRAL FLOW CONTROL ENHANCEMENTS* • DTEs AT ARTCCs AND PACING AIRPORTS	• ADDITIONAL CENTRAL FLOW ENHANCEMENTS	• CENTRAL FLOW WEATHER SERVICE UNIT
FLIGHT SERVICE FACILITIES	FLIGHT SERVICE DATA PROCESSING SYSTEM (FSDPS), AUTOMATED FLIGHT SERVICE STATION, (AFSS) • MODEL 1 (1982-83)* - AUTOMATED SUPPORT TO SPECIALIST: WEATHER AND AERONAUTICAL INFORMATION MAINTENANCE AND RETRIEVAL, FLIGHT PLAN PROCESSING AND AUTOMATED ALERTS - DIGITIZED WEATHER RADAR AT 44 EFAS SITES • MODEL 2 (1983-84)* - DIRECT USER ACCESS TO WEATHER BRIEFING AND FLIGHT PLAN FILING - SELECTIVE WEATHER RETRIEVAL - IMPROVED GRAPHICS AND MULTIPLE WEATHER RADAR - AUTOMATED SUPPORT TO EMERGENCY ASSISTANCE • AVIATION WEATHER PROCESSOR (AWP) - CENTRALIZED MAINTENANCE OF WEATHER AND AERONAUTICAL INFORMATION	FSDPS/AFSS/AWP • AWP/WEATHER MESSAGE SWITCHING CENTER (WMSC) CONSOLIDATION* • INTEGRATED VOICE RESPONSE SYSTEM (VRS)* • CONSOLIDATED MODEL 2, MODEL 3	• COLOR GRAPHICS • PILOT ACCESS TO WEATHER FLIGHT PLAN FILING VIA DABS DATA LINK • AVIATION WEATHER SYSTEM (AWES) • SPECIALIST ASSISTED VRS

*APPROVED BY THE FAA FOR IMPLEMENTATION

TABLE 1-2
(CONTINUED)

FACILITY	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
EN ROUTE SURVEILLANCE	• DUAL COMMON DIGITIZER (CD-2)*	• NEXT GENERATION WEATHER RADAR (NEXRAD) • AIR ROUTE SURVEILLANCE RADAR (ARSR-4) • MOVING TARGET DETECTOR (MTD) • RMMS FOR EN ROUTE SURVEILLANCE SITES • ARSR WEATHER CHANNEL	• DABS SURVEILLANCE, DATA LINK, ATARS • ATARS TERRAIN AVOIDANCE
TERMINAL SURVEILLANCE	• RADAR BEACON TRANSPONDER FOR BCAS (RBX)	• DABS SURVEILLANCE, DATA LINK, ATARS • NEXT GENERATION WEATHER RADAR (NEXRAD) • AIRPORT SURVEILLANCE RADAR (ASR-9) • MOVING TARGET DETECTOR • ASR WEATHER CHANNEL • RMMS FOR TERMINAL SITES	• LIMITED SURVEILLANCE RADAR (LSR) • FAA TERMINAL WEATHER RADAR
NAVIGATION	• SOLID STATE VORTACs* • RMMS FOR VORTACs* • HEAD UP DISPLAY (HUD) • MICROWAVE LANDING SYSTEM (MLS)		• 4D NAVIGATION • NAVSTAR GLOBAL POSITIONING SYSTEM (GPS) • IFR HELICOPTER OPERATIONS • COCKPIT DISPLAY OF TRAFFIC INFORMATION (CDTI)
VOICE COMMUNICATION	• SOLID STATE TRANSMITTERS AND RECEIVERS AND IMPROVED ANTENNAS FOR ALL AIR/GROUND SITES* • DIRECTION FINDING EQUIPMENT REPLACEMENT* • REMOTE CENTER AIR/GROUND (RCAG) REMOTE MONITORING SUB-SYSTEM (RMS)* • MAINTENANCE PROCESSOR SUBSYSTEM(MPS)* • VOICE SWITCHING AND CONTROL SYSTEM (VSCS) (VOICE FREQUENCY SIGNALING AND CONTROL SYSTEM) • VSCS (FSS) • VSCS (TERMINAL)	• VSCS (EN ROUTE) • VSCS (TECHNICAL CONTROL SUBSYSTEM)	

*APPROVED BY THE FAA FOR IMPLEMENTATION

TABLE 1-2
(CONCLUDED)

FACILITY	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
DATA COMMUNICATION	• INITIAL NADIN* - PROVIDES DATA COMMUNICATIONS FOR AREA B, CENTER B, NASNET, AFTN, UTILITY B, WMSC INTERFACE, NWS INTERFACE, ATCCC (INTERIM), CANADIAN AFTN, ARINC DATA INTERFACE • NADIN 1A* - PROVIDES DATA COMMUNICATIONS FOR THE FLIGHT SERVICE AUTOMATION SYSTEM (MODEL II) AND THE FLIGHT DATA INPUT OUTPUT (FDIO) SYSTEM AND NFDC INFORMATION SYSTEM (INTERIM)	• NADIN ENHANCEMENTS - PROVIDES DATA COMMUNICATIONS FOR NATIONAL FLIGHT DATA CENTER (FINAL), ATCCC (FINAL), COMPUTER B, MODERNIZED WEATHER SERVICE, RMMS (MPS-MPS), DOT DATA COMMUNICATIONS NETWORKS • DABS/DATA LINK • DATA COMMUNICATION SYSTEM FOR THE ATC COMPUTER REPLACEMENT	• EXPANDED DABS DATA LINK COMMUNICATIONS

*APPROVED FOR IMPLEMENTATION

1.2.3 Document Structure

The work undertaken in this study has resulted in a number of outputs. This document describes the system evolution and interfaces for specific facilities. A series of short papers that focus on some of the system configuration and design issues to be addressed by FAA management were also prepared as a result of developing the material and reviewing this document with FAA management and program managers. These papers have been used to track progress in resolving specific issues and are updated and published by the Systems Research and Development Service. These papers are referenced in this document.

Each facility description chapter in this report follows roughly the same outline. The intent was to highlight system interface requirements between particular facilities and between particular improvements within a given facility for each of the three time periods. For example, the En Route Facilities Chapter highlights interfaces between ARTCC automation and en route surveillance sites as well as interfaces internal to the ARTCC automation, such as between the Electronic Tabular Display Subsystem (ETABS) and the Direct Access Radar Channel (DARC).

Each facility description consists of:

- an improvements summary
- an information flow diagram
- a connectivity diagram

- a tentative implementation schedule

- an interface planning summary

The improvements summary gives a brief description of each improvement and the expected advantages that will accrue to the system by its implementation.

The information flow diagram presents the specific inputs, outputs, and internal functions that must be accomplished for each ATC system improvement.

The connectivity diagram specifies the type of data directly relating to the delivery of ATC services and the general transmission media (for data communications: directly wired, digital data channel, teletypewriter channel, video channel, or facsimile transmission; for voice communications: voice phone, or VHF/UHF radio) associated with interfacility communication links. Within the facility chapter, the designation of communication media is at the general level. The specific FAA leased or operated switching and transmission capabilities used for these links is given in the Communications Facilities Chapter.

For each of the preceding sections, the emphasis is on the system interface changes that will occur in the Near Term and Far Term periods, with minimum attention given to explaining the operation of the existing system except as a point of reference.

The tentative implementation schedule is based on projected Technical Data Package (TDP) handoff dates for improvements to

be derived from the E&D program and on F&E budgetary information for improvements that are being acquired directly by the operating services. The implementation dates follow TDP handoff by one to three years, depending on the estimated complexity of the procurement. The changeable and rather optimistic nature of these estimates, particularly for Far Term items, limits their usefulness in examining fine grained precedence relationships.

The interface planning summary identifies some of the major assumptions that were necessarily made as to what improvements would be implemented and how they would function. Follow-up on these issues has been undertaken on a continuing basis with a joint Systems Research and Development Service and Airway Facilities Service group. As a result of this group's review and resolution process these assumptions are expected to change with some issues being closed out and some new issues being added. The reader is cautioned to review actions of this group before any final conclusions are formed. Table 1-3 provides an index of the issues cited in each of the following chapters. The issues in Table 1-3 correspond to the set of issues under consideration by the joint group as of December 1980, and the item numbers are consistent with those assigned by the group.

TABLE 1-3
INDEX OF SYSTEM INTEGRATION ISSUES

SYSTEM INTEGRATION ISSUE		ATC FACILITY							
NO.	TITLE	En Route	TRACON	Tower	ATCCC	FSS	Surveillance	Navigation	Communication
101	Backup ATC Capability—Catastrophic	X							
103	RMMS Interaction with R&D Products						X		X
104	80's Maintenance Concept-System Complexity								X
201	Mode C Intruder (Conflict Alert)	X							
202	ATARS -- Controller Alert Notices	X	X				X		
203	DARC -- CCC -- DABS	X							
204	Use of the DABS Data Link	X							
205	CMA Development Activities	X							
206	Weather Program Definition	X					X		
207	CWSU Concept	X					X		
208	ARTCC Software for use with DABS	X					X		
211	VSCS -- 9020 Relationship	X							X
212	DABS Maintenance Concept						X		
215	VSCS-Tone Channeling Equipment								X
216	TABG Tracker Coast Processing		X						
301	ARTS II Enhancements		X						
302	ARTS II — DABS Interface		X				X		
304	ARTS IIIA System Definition & Capability		X						
305	ARTS IIIA Software for DABS ERA		X				X		
310	ATARS at Multiple Beacon ARTS IIIA		X				X		
315	Consolidation of TRACONS		X						

TABLE 1-3
(CONCLUDED)

SYSTEM INTEGRATION ISSUE		ATC FACILITY							
NO.	TITLE	En Route	TRACON	Tower	ATCCC	FSS	Surveillance	Navigation	Communication
317	ARTS IIIA Hardware for DABS		X				X		
326	SRAP		X				X		
330	TPX-42 Replacement		X						
331	VAS -- M&S; AVS -- M&S		X	X					
333	Full BCAS -- ASR Antenna Rotation						X		
405	Traffic Flow Management	X	X		X				
602	AWP-WMSC Combined Function					X			
604	VSCS Support to AFSS's					X			X
605	FSS-DABS Data Link Utilization					X			
606	Voice Communications Equipment for Non-Automated FSSs					X			X
607	Part-Time Use of Non-Automated FSSs					X			X
702	DABS ATARS Operational Procedures	X					X		
706	ATARS -- Non-Mode C Aircraft	X	X				X		
707	ATARS Terrain Avoidance, Term MSAW		X				X		
710	ASR-9 at ARTS IIIA Sites		X				X		
711	Reconstituted Video-DABS		X				X		
712	Future Role of Primary Radar						X		
713	NEXRAD Deployment						X		
801	Use of the MLS Data Link							X	
803	MLS Display Requirements							X	
804	Candidates for Civil Aviation Navigation							X	
805	Compatibility of Existing and Planned Navigation Systems							X	
905	NADIN Interface with TIDS & ARTS								X

2. EN ROUTE FACILITIES

This chapter describes the system improvements planned for En Route Facilities and the interfaces with other ATC facilities for Current, Near Term, and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1.

As described in this chapter, an En Route Facility consists generally of those portions of the en route air traffic control system that are contained in the ARTCC (Air Route Traffic Control Center) building. The facility consists of en route ATC (Air Traffic Control) system equipment, en route ATC system software, and the personnel associated with this equipment and software. Other equipment and functions are physically located at en route facilities but are not discussed in this chapter. For example, NADIN (National Airspace Data Interchange Network) concentrators, NADIN switches, and voice radio equipment are, or will be, located at en route facilities. These are described in the Communications Facilities chapter (Chapter 9). Similarly, Flight Service Data Processing Systems (FSDPS) are to be located at ARTCCs but are described in the Flight Service Facilities chapter (Chapter 6) rather than in this chapter.

The emphasis in this chapter is on future improvements to those en route functions directly related to the providing of ATC services. Administrative functions, maintenance (with the exception of new automated capabilities), logistics, etc., are not included. The communications within the building and between the building and other elements of the system are generally not described; however, the external interfaces and the types of information sent across these interfaces are

indicated.

The remainder of this chapter consists of the following sections:

- En Route Facilities Improvements (2.1). This section lists important functions/features and the improvements planned for them. For each function/feature, there is a brief description of the function and the planned improvement(s). The section contains three Information Flow Diagrams -- one for each of the three system phases: Current, Near Term, and Far Term. The diagrams show:

    - the facilities that provide inputs to an ARTCC

    - the principal types of inputs provided by each of these facilities

    - ARTCC functions

    - the facilities that are provided with outputs from an ARTCC

    - the principal types of outputs provided to those facilities by the ARTCC

- En Route Facilities Connectivity (2.2). This section contains three connectivity diagrams -- one for each of the three system phases (see above). The changes in connectivity between phases are briefly described.

- En Route Facilities Tentative Implementation Schedule (2.3). This section contains a figure that shows the tentative implementation schedule for the principal improvements affecting the En Route Facilities.

- En Route Facilities Interface Planning Summary (2.4). This section summarizes the major assumptions that were made in regard to the implementation and interfacing of the various improvements.

2.1 En Route Facilities Improvements

Table 2-1 summarizes the En Route Facilities improvements and related improvements that, according to current plans, are expected to be implemented in the Near Term and Far Term. There are other improvements that are, according to current plans, less likely to be implemented. These are listed as Potential and Longer Range Improvements in the same table. Related improvements such as DABS (Discrete Address Beacon System), ATARS (Automated Traffic Advisory and Resolution Service), and BCAS (Beacon Collision Avoidance System) are also cited. Although these are not contained within ARTCC buildings, they perform functions similar to ARTCC functions, or they are closely interfaced with ARTCC functions.

Figures 2-1, 2-2, and 2-3 show respectively the Current, Near Term, and Far Term information flow between an En Route Facility (ARTCC) and other elements of the ATC system. In each figure, the ARTCC is shown as a large box in the middle. The inputs to the ARTCC are shown to the left of the box; the outputs from the ARTCC are shown to the right. Within the box itself,

TABLE 2-1
EN ROUTE FACILITIES IMPROVEMENTS SUMMARY

Functions/Features	Current System (1980)	Near Term Improvements (1981-84)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
1. En Route Data Processing Equipment	• CCC (9020As or 9020Ds) • Display Channel Processor (CDC or 9020E) • DARC • SMMC	• DARC Enhancements • Maintenance Processor Subsystem	• ETABS	• 9020 Replacement • Offloading of DYSIM to RTF • Offloading of Data Recording to off-line recorders • Offloading of RTQC to DARC • Offloading of RDP onto DARC • Applications Processor for DABS Data Link
2. En Route Input/Output Equipment	• CED • CRD • PVD • FSP • Broadband Surveillance Data Capabilities • DARC • CWSU at ARTCC	• FSP Replacement with FDIO* • DARC Enhancements • CWSU Weather Displays (RRWDS)* • Sector Weather Displays (EWEDS)	• ETABS • Removal of Broadband Surveillance Capabilities • CWSU Enhancements	• Radar Console Improvements • Sector Suite • ETABS Backup • ETABS Interfaces with DARC and Adjacent ARTCCs • CWPC • Display of Three-Dimensional Weather Data
3. Processing and Display of ATC and Related Data	• ATC & Weather Data on PVDs	• Tracking Enhancements in DARC • RMMS Data for RCAGs* and VORTACs*	• DABS/ATARS Data from Selected Terminal Surveillance Sites • RMMS Data for En Route Surveillance Sites • Data to TIDS	• DABS/ATARS Data from En Route Surveillance Sites • DABS Data Link • AERA
4. Aircraft Separation Services	• Conflict Alert	• IFR/VFR Conflict Advisory Function • Conflict Resolution Advisory • BCAS (Active)	• ATARS Data from Selected Terminal Surveillance Sites	• ATARS Data from En Route Surveillance Sites • DABS Data Link • AERA • BCAS (Full)
5. Communication with Aircraft	• Voice via Radio	NC	NC	• DABS Data Link • CMA
6. Detection of Unsafe/Unacceptable Use of Airspace	• En Route MSAW	NC	NC	• ATARS Terrain, Obstacle, and Special Airspace Avoidance • Use of DABS Data Link for Advisories • AERA
7. Traffic Flow Management	• En Route Metering I • Local Flow Control	• En Route Metering II*	• Interface between En Route Metering & Terminal Sequencing and Spacing	• Integrated Flow Management • AERA

*	Approved by the FAA for Implementation	FDIO	Flight Data Input Output Equipment
AERA	Automated En Route Air Traffic Control	FSP	Flight Strip Printer
ATARS	Automatic Traffic Advisory and Resolution Service	IFM	Integrated Flow Management
BCAS	Beacon Collision Avoidance System	IOCE	Input/Output Control Element
CCC	Central Computer Complex	MSAW	Minimum Safe Altitude Warning
CDC	Computer Display Channel	NC	No Change Included in Current Plans
CED	Computer Entry Device	PVD	Plan View Display
CMA	Control Message Automation	RCAG	Remote Communications Air-Ground
CRD	Computer Readout Display	RDP	Radar Data Processing
CWPC	Center Weather Processing Complex	RMMS	Remote Maintenance Monitor System
CWSU	Center Weather Service Unit	RRWDS	Remote Radar Weather Display System
DABS	Discrete Address Beacon System	RTF	Radar Training Facility
DARC	Direct Access Radar Channel	RTQC	Real-Time Quality Control (of Radar)
DYSIM	Dynamic Simulation	SMMC	System Maintenance Monitoring Console
ETABS	Electronic Tabular Display Subsystem	TIDS	Terminal Information Display System
EWEDS	En Route Weather Display System	VORTAC	Very High Frequency Omnirange Station colocated with Tactical Air Navigation

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- Tower En Route Messages
- PIREPs

From Tower Cab
- Flight Plan Data (FDEP)

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Canadian En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-Dimensional Weather Data (WPMD)
  - Broadband (Video) Aircraft and Two-dimensional Weather Returns (range, azimuth)
- ATCRBS
  - Digitized Aircraft Target Reports (range, azimuth identification, altitude)
  - Broadband (Video) Aircraft Replies (range, azimuth identification, altitude)

From NWS Weather Radar
- Digitized Two-dimensional (Precipitation) Weather Data

From National Weather Service
- FAX Maps

From ATCCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Traffic Quotas
- FAD Information

From Flight Service Facility (Flight Service Station)
- Requests for PIREPs
- IFR Flight Plans, FP Changes
- NOTAMs

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

From Satellite Field Service Station
- NOAA Satellite Pictures

Current En Route Facility

FUNCTIONS FEATURES

1. En Route Data Processing Equipment
   Central Computer Complex (9020As or 9020Ds)
   Display Channel Processor (Computer Display Channel or 9020E)
   Direct Access Radar Channel
   System Maintenance Monitoring Console

2. En Route Input/Output Equipment
   Computer Entry Device
   Computer Readout Display
   Plan View Display
   Flight Strip Printer
   Broadband Surveillance Data Capabilities
   Direct Access Radar Channel

3. Processing and Display of ATC and Related Data
   Central Weather Service Unit at ARTCC
   ATC and Weather Data on Plan View Displays

4. Aircraft Separation Services
   Conflict Alert

5. Communication with Aircraft
   Voice via Radio

6. Detection of Unsafe/Unacceptable Use of Airspace
   En Route Minimum Safe Altitude Warning

7. Traffic Flow Management
   En Route Metering I

NOTE: In addition to the indicated flow, voice telephone coordination is used between the ARTCC and most other facilities.

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

To TRACON/TRACAB (ARTS III, ARTS II, or TPX-42)
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Progress Strip Data (FDEP)
- General Information Messages
- Tower En Route Messages
- PIREPs

To Tower Cab
- Flight Plan and Flight Progress Strip Data (FDEP)

To Military Base Operations Office
- General Information Messages

To Airline Dispatch Office
- General Information Messages
- Bulk Flight Plan Readouts

To Canadian En Route Facility
- Flight Plans, FP Changes
- General Information Messages
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To ATCCC
- Requests for Assistance in Handling Calamities or Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Pacing Airports (Non-Air-Carrier Flight Plans, Departure Messages (Domestic Flights), Remove Strip Messages)
- Diversion Messages

To Flight Service Facility (Flight Service Station)
- PIREPs

To National Weather Service
- PIREPs

FIGURE 2-1
CURRENT EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON/TRACAB (ARTS IIIA, ARTS II, or TPX-42)
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDIO)
- General Information Messages (FDIO)
- Tower En Route Messages
- PIREPs

From Tower Cab
- Flight Plan Data (FDIO)

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Canadian En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (CD-2 Common Digitizer)
  - Broadband (Video) Aircraft and Two-dimensional Weather Returns (range, azimuth) (Precipitation)
- ATCRBS
  - Digitized Aircraft Target Reports (range, azimuth identification, altitude)
  - Broadband (Video) Aircraft Replies (range, azimuth, identification, altitude)

From NWS Weather Radar
- Digitized Two-dimensional (Precipitation) Weather Data

From National Weather Service
- FAX Maps

From ATCCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Quota Flow Control Information
- FAD Information

From Flight Service Facility
- IFR Flight Plans, FP Changes
- Requests for PIREPs
- NOTAMs

From Weather Message Switching Center
- Weather and Altimeter Data
- PIREPs
- NOTAMs

From Satellite Field Service Station
- NOAA Satellite Pictures

Near Term En Route Facility

FUNCTIONS/FEATURES

1. En Route Data Processing Equipment
   Direct Access Radar Channel Enhancements
   Maintenance Processor Subsystem
2. En Route Input/Output Equipment
   Flight Strip Printer Replacement with Flight Data Input Output Equipment
   Radar Remote Weather Display System (RRWDS)
   Sector Weather Displays (EWEDS)
   Remote Maintenance Monitor System for Remote Communications Air-Ground and Very High Frequency Omnirange Station Colocated with Technical Air Navigation
3. Processing and Display of ATC and Related Data
   Tracking Enhancements in Direct Access Radar Channel
4. Aircraft Separation Services
   IFR/VFR Conflict Advisory Function
   Conflict Resolution Advisory Function
   Beacon Collision Avoidance System (Active)
5. Communication with Aircraft
   No Change
6. Detection of Unsafe/Unacceptable Airspace
   No Change
7. Traffic Flow Management
   En Route Metering II

Underlined words = changes from Current version to Near Term version of system

NOTE: In addition to the indicated flow, voice telephone coordination is used between the ARTCC and most other facilities.

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

To TRACON/TRACAB (ARTS IIIA, or ARTS II)
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Progress Strip Data (FDIO)
- General Information Messages
- PIREPs
- CWSU Weather Data

To Tower Cab
- Flight Plan and Flight Progress Strip Data (FDIO)

To Military Base Operations Office
- General Information Messages

To Airline Dispatch Office
- General Information Messages
- Bulk Flight Plan Readouts

To Canadian En Route Facility
- Flight Plans, FP Changes
- General Information Messages
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To ATCCC
- Requests for Assistance in Handling Calamities or Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Expanded Number of Selected Airports (Non-Air-Carrier Flight Plans, Departure Messages (Domestic and International Flights), Remove Strip Messages)
- Arrival and Diversion Messages
- Progress Reports
- Data Requests

To Flight Service Facility
- PIREPs

To Weather Message Switching Center
- PIREPs

FIGURE 2-2
NEAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

INPUTS

From Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

From TRACON TRACAB (ARTS IIIA, ARTS II, TPX-42 with <u>TIDS Data Interface</u>)
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (<u>TIDS</u>)
- General Information Messages (<u>TIDS</u>)
- Tower En Route Messages
- PIREPs
- <u>Metering Data</u>

From Tower Cab
- Flight Plan Data (FDIO)

From Military Base Operations Office
- Flight Plans, FP Changes

From Airline Dispatch Office
- Flight Plans, FP Changes
- Bulk FP Readout Requests

From Canadian En Route Facility
- Flight Plans, FP Changes
- Departure Messages
- Handoff Messages

From Aircraft (Air Crew, <u>Data Link Available</u>)
- Flight Plans, <u>Requests for FP Changes</u>
- Requests for Information
- Progress Reports
- PIREPs

From En Route Surveillance Site
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather Data (CD-2 Common Digitizer)
- ATCRBS
  - Digitized Aircraft Target Reports (range, azimuth) identification, altitude)

From Terminal Surveillance Site (<u>DABS-equipped</u>)
- Search Radar
  - Digitized Aircraft Target Reports (range, azimuth)
  - Digitized Two-dimensional Weather (precipitation) Data
- DABS
  - <u>Digitized DABS/ATCRBS Aircraft Target Reports (range, azimuth, identification, altitude)</u>
  - <u>Controller Advisory (ATARS, BCAS Messages</u>
  - <u>Track Alert Messages</u>

<u>From NEXRAD Weather Radar Site</u>
- Digitized <u>Three-dimensional</u> Weather (precipitation <u>and turbulence</u>) Radar

From National Weather Service
- FAX Maps

From ATCCC
- Assistance in Handling Calamities or Impending Calamities
- Traffic Forecasts
- Quota Flow Control Information
- FAD Information

From Flight Service Facility
- IFR Flight Plans, FP Changes
- Requests for PIREPs
- NOTAMs

From Weather Message Switching Center/Aviation Weather Processor
- Weather and Altimeter Data
- PIREPs
- NOTAMs
- Weather Maps

From Satellite Field Service Station
- NOAA Satellite Pictures

Far Term En Route Facility

FUNCTIONS FEATURES

1. En Route Data Processing Equipment
   <u>Electronic Tabular Display Subsystem</u>

2. En Route Input Output Equipment
   <u>Electronic Tabular Display Subsystem</u>
   <u>Removal of Broadband Surveillance Capabilities</u>
   <u>Remote Maintenance Monitor System for En Route Surveillance Sites</u>
   <u>Central Weather Service Unit Enhancements</u>

3. Processing and Display of ATC and Related Data
   <u>DABS/ATARS Data from Selected Terminal Surveillance Sites</u>

4. Aircraft Separation Services
   <u>DABS/ATARS Data from Selected Terminal Surveillance Sites</u>

5. Communication with Aircraft
   No Change

6. Detection of Unsafe/Unacceptable Use of Airspace
   No Change

7. Traffic Flow Management
   <u>Interface Between En Route Metering and Terminal Sequencing and Spacing</u>

Underlined words = changes from Near Term version to Far Term version of system

NOTE: In addition to the indicated flow, voice telephone coordination is used between the ARTCC and most other facilities.

OUTPUTS

To Adjacent ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Holds

To TRACON TRACAB (ARTS IIIA with TIDS Data <u>Interface</u> or ARTS II)
- Flight Plans, FP Changes
- Handoff and Track Messages
- General Information Messages
- <u>CWSU Weather Data</u>
- <u>Metering Data</u>

To Tower Cab
- Flight Plan Data (<u>TIDS</u> or FDIO) and Flight Progress Strip Data (FDIO)

To Military Base Operations Office
- General Information Messages

To Airline Dispatch Office
- General Information Messages
- Bulk Flight Plan Readouts

To Canadian En Route Facility
- Flight Plans, FP Changes
- General Information Messages
- Departure Messages
- Handoff Messages

To Aircraft (Air Crew, <u>Data Link Available</u>)
- Clearances
- FP Modification
- Instructions, Advisories
- Requests for PIREPs

To Terminal Surveillance Site (<u>DABS-equipped</u>)
- <u>DABS</u>
  - Aircraft Control State Messages

To ATCCC
- Requests for Assistance in Handling Calamities or Impending Calamities
- Flow Control Data
- Status and Weather Data
- Activity Messages for Expanded Number of Selected Airports (Non-Air-Carrier Flight Plans, Departure Messages, Remove Strip Messages)
- Arrival and Diversion Messages
- Progress Reports
- Data Requests

To Flight Service Facility
- PIREPs

To Weather Message Switching Center/Aviation Weather Processor
- PIREPs

FIGURE 2-3
FAR TERM EN ROUTE FACILITIES INFORMATION FLOW DIAGRAM

functions/features are listed. For the Near Term and Far Term figures, these are the new functions/features that are expected to be available at the end of the period for which the figure was prepared. The Current figure shows the functions/features as they existed in December 1980. In some cases, the inputs and outputs that are listed are general categories of inputs and outputs rather than all of the input and output message types within the categories.

The principal changes in information flow and in functions from the Current system to the Near Term system are underlined in Figure 2-2. Similarly, underlining is used in Figure 2-3 to indicate the principal changes from the Near Term system to the Far Term system. The changes in functions, the inputs to the functions, and the outputs from the functions are described in the following paragraphs.

2.1.1 En Route Data Processing Equipment

This section and the following section (2.1.2 En Route Input/Output Equipment) are concerned with the computer hardware in the ARTCC building, as opposed to software, software functions, and data processing. The equipment described in this section is primarily used for data processing. However, such equipment has input/output characteristics that make it difficult to separate the data processing equipment from the input/output equipment that is described in the next section. In particular, DARC (Direct Access Radar Channel) and ETABS (En Route Tabular Display Subsystem) are concerned with both data processing and input/output. They have therefore been included in both sections. The other major ARTCC data processing

equipments included in this section are: Central Computer Complex, Display Channel Processor, Maintenance Processor Subsystem, and the potential Applications Processor for DABS (Discrete Address Beacon System) Data Link.

2.1.1.1 Current System

Principal Data Processing Equipment

IBM 9020As and 9020Ds are used as CCCs (Central Computer Complex). IBM 9020Es are used as Display Channel Processors in some ARTCCs. Most ARTCCs use CDCs (Computer Display Channel) as Display Channel Processors.

DARC

DARC (Direct Access Radar Channel) equipment has recently been installed at ARTCCs to provide a backup display capability for surveillance information. It furnishes controllers with plan view display capabilities when such capabilities are not available through the primary surveillance channel. DARC will normally be used when there is a failure in the primary surveillance data display capability. It also may be used to free the ARTCC's data processing capabilities, or portions thereof, for maintenance work while still allowing 24-hour-a-day operation of the ARTCC. PVDs are supplied with an additional backup surveillance display capability through broadband data that is sent from the surveillance sites. The broadband capability allows the display of beacon replies and search radar returns (including weather targets), but does not provide data block labels for aircraft, altitude displays (Mode C and

Assigned), or map data displays. DARC does provide these latter capabilities as well as the display of beacon replies and search radar returns.

Maintenance

The System Maintenance Monitoring Console (SMMC) in the ARTCC provides a centralized monitoring and control capability for the ARTCC's Systems Engineers. For the equipment within the ARTCC building, extensive status information is automatically sent to the SMMC on a regular schedule. For remotely located equipment, much less information is automatically made available to the SMMC, and therefore, periodic visits of maintenance personnel to the remote sites are required in order to perform most maintenance and certification functions. For en route surveillance sites, status messages are periodically sent to the SMMC. For Navigation Aids and RCAGs (Remote Communications Air/Ground), information must be entered manually at the SMMC after it is received by voice telephone.

2.1.1.2 Near Term Improvements

Principal Data Processing Equipment

There are no Near Term improvements planned for the CCC or Display Channel Processor.

DARC

DARC will be enhanced with a number of features including automatic tracking, a substantial two-way interface with the

CCC, surveillance data mosaicking, Conflict Alert, EMSAW (En Route Minimum Safe Altitude Warning), automatic assignment of beacon codes, and improved keyboard control. The latter will allow DARC to have almost all of the controller entry and readout capabilities that are currently available at the "R" Position Console when it is being serviced by the primary surveillance channel.

Maintenance

Improvements in the maintenance of remote facilities are planned through the use of automation techniques. New data processing equipment at ARTCCs will communicate with automated monitoring equipment at the remote sites. The equipment at each ARTCC will be a Maintenance Processor Subsystem (MPS). In the Near Term, MPSs will control and communicate with Remote Monitor Subsystems (RMS) at RCAGs and VORTACs (Colocated VOR (Very High Frequency Omnirange Station) and TACAN (Tactical Air Navigation)). The MPSs will thus build up a central data base for the various remote equipments. The MPSs and RMSs are part of the Remote Maintenance Monitor System (RMMS). This system is expected to improve the use of personnel resources and the availability of remote systems. Maintenance personnel will be provided with terminals to access the MPS data base containing current status and historical information concerning equipment performance. The basic capabilities being addressed by the RMMS program at the present time are: monitoring equipments and alarms, remote certification, automated recordkeeping, trend analysis, failure prediction, and remote control of power sources. Monitored parameters would be continuously scanned and compared against stored standards. Certification would be provided remotely if

the parameters were found to be within a specified acceptable range. Facility logs and facility performance reports would be kept automatically by the central processor, and outages would be automatically reported. The trend analysis would provide an early detection of weak links and a long term evaluation of Mean Time Between Failures (MTBF) and Mean Time Between Repairs (MTBR). The remote control capability might be limited to generator activation/deactivation.

Since this document concentrates on those functions directly related to the providing of ATC services, RMMS and other maintenance functions are not shown in the connectivity diagrams contained in Section 2.2. Similar capabilities are expected for TRACONs and Towers under a separate program. The relationship between the TRACON/Tower RMMS program and the En Route RMMS is not well defined at the present time.

2.1.1.3 Far Term Improvements

Principal Data Processing Equipment

There are no Far Term improvements planned for the CCC, Display Channel Processor, or DARC.

ETABS

ETABS (Electronic Tabular Display Subsystem) is expected to be implemented in the Far Term. ETABS is primarily concerned with aiding controllers in their entry and readout of data. However, it can perform data processing functions such as routing of information among sectors, maintaining a flight data base, and

providing substantial support to sector operations when the CCC is not operational. ETABS is more fully described in 2.1.2.3.

Maintenance

Far Term plans call for RMMS to be extended to include En Route surveillance radars. RMSs would be deployed at the surveillance sites and would communicate with the MPS at the host ARTCC. Search radar, beacon, and Common Digitizer equipment would be monitored by the new RMSs.

2.1.1.4 Potential and Longer Range Improvements

Principal Data Processing Equipment

At some ARTCCs, the current en route computer equipment and software are being used close to their maximum capabilities. Within a few years, at these sites, it may not be possible to satisfy the en route operational and maintenance requirements with the current equipment and software. Increased needs are anticipated in regard to computer capacity, reliability, and maintainability:

- Increases in traffic load and the incorporation of new functions/features will require increased computer capacity.

- Reliability needs to be increased because it is expected that fewer qualified controller personnel per controlled aircraft will be available for manual backup in case of automation failures.

- Because of aging equipment and possible difficulties in obtaining replacement parts, maintenance may become increasingly difficult.

Studies are now underway to determine the best course of action to be taken to achieve increased computer capacity, reliability, availability, and maintainability. The replacement of en route computers is expected to occur in the late 1988 to 1990 time frame. In the meantime, various measures are being considered to decrease the load on the 9020s and particularly on the CCC:

- Minimizing the use of the Dynamic Simulation (DYSIM) capabilities by performing controller training at the Radar Training Facility at Oklahoma City rather than at ARTCCs.

- Offloading of Data Recording to offline recorders.

- Offloading of the Real Time Quality Control of radar (RTQC) to DARC.

DARC

A number of potential improvements are being considered in connection with DARC. The possibility of isolating Radar Data Processing (RDP) from Flight Data Processing (FDP) within the CCC is being investigated. The goal would be to remove RDP from the CCC and perform it within DARC. This removal of the RDP load from the CCC would allow the CCC to perform FDP even if there were substantial increases in traffic load or if there were fewer CCC storage elements available.

Data Link Applications Processor

A special applications processor may be needed at each ARTCC to handle DABS/Data Link requirements.

Maintenance

Potential improvements in the RMMS capability include remote diagnostics, isolation of failing equipment, and remote adjustment of equipment. They also include failure anticipation and scheduling of corrective action prior to malfunction. Computer files of equipment problems and solutions may also be incorporated.

2.1.2 En Route Input/Output Equipment

This section and the previous section (2.1.1 En Route Data Processing Equipment) are concerned with equipment in the ARTCC building, as opposed to software, software functions, and data processing. The equipment described in this section is primarily concerned with the input and output of information to equipment and personnel at the ARTCC. Most of the devices that allow controllers to enter or see data are included. Equipments concerned with the input of surveillance and weather data are also included. For convenience sake, the general subject of aviation weather is also treated here. DARC and ETABS are included here as well as in 2.1.1.

2.1.2.1 Current System

Controllers' Input/Output Equipment

The data input/output equipments used by en route controllers are:

- Computer Entry Devices (CED)
- Computer Readout Displays (CRD)
- Plan View Displays (PVD) (part of the Radar Controller Console)
- Data Entry Controls (DEC) (the part of the Radar Controller Console that allows the entry of data through the Alphanumeric Keyboard, Trackball, and Quick Action Keys; and allows the control of the PVD through Display Filter Keys, Range Control, Off-centering Keys, etc.).
- Flight Strip Printers (FSP)

FDEPs and FSPs

ARTCCs communicate with Flight Data Entry and Printout equipment (FDEP) at TRACONs/Towers. The equipment is primarily used to collect and disseminate flight plan data and flight progress strips. The current FDEP equipment requires excessive maintenance, particularly on the printers, and causes operational delays or backlogs because of its low printing rate of approximately 10 characters per second. Similar difficulties

are experienced with the FSPs in the ARTCC.

Surveillance Data Input Equipment

A limited backup capability for ARTCC sector control positions is currently provided through DARC. This improvement was described in 2.1.1.1. Broadband surveillance data capabilities are available to Radar Controllers through the primary surveillance channel. The displayed data is frequently used by controllers for its ability to show weather conditions.

Weather

Currently, the collection, processing, and dissemination of aviation weather is partially integrated within an ARTCC through the ARTCC's CWSU (Center Weather Service Unit). CWSUs are located in all ARTCCs to provide a consolidation of ARTCC weather services. The CWSUs are designed to be the major focal points for real-time collection, monitoring, interpretation, and dissemination of hazardous weather information. Professional meteorologists man each CWSU. They monitor weather developments and provide general weather briefings and hazardous weather advisory service to controllers. One of their duties is the collection, interpretation, and dissemination of PIREPs (Pilot Reports). Each CWSU has:

- a PVD with a capability of selectively viewing all sectors within the ARTCC

- WBRRs (Weather Bureau Remote Radar recorders) that receive their data from NWS WSR-57 radars

- a facsimile machine for receiving weather maps
- a GOES (Geostationary Operational Environmental Satellite) satellite photo recorder that receives its information from a Satellite Field Service Station
- a Service "A" teletypewriter drop for receiving weather information from the WMSC
- telephone and interphone service.

2.1.2.2 Near Term Improvements

Controllers' Input/Output Equipment

No Near Term changes are planned for CEDs, CRDs, and Radar Controller Consoles.

FDEPs, FSPs, and FDIOs

In the Near Term, the CCC input/output situation will be improved through the replacement of Flight Strip Printers (FSP) and Flight Data Entry and Printout (FDEP) equipment. The new equipment, FDIO (Flight Data Input Output), is being procured to satisfy the needs for faster operation, greater flexibility, greater reliability, and increased ease of maintenance.

At the ARTCCs, the FSPs will be replaced by FDIO printers that will print at a speed of at least 30 characters per second. At the TRACONs/Towers, the FDEPs will be replaced with FDIO Cathode Ray Tube (CRT) displays, keyboards, and printers. The FDIO

control equipment at TRACONs/Towers will communicate with the CCC at a rate of 2400 bits per second (bps). The minim[illegible]a rate capabilities of the input/output equipment at the TRACONs/Towers will be: CRT - 2400 bps, Keyboard - 1200 bps, and Printer - 30 characters per second. Through its use of multiplexing techniques, FDIO will reduce the CCC communications load and sharply reduce the number of adapter and control units connected to the CCC.

Surveillance Data Input Equipment

DARC will be enhanced with a number of features. These were described in 2.1.1.2.

Weather

Radar Remote Weather Display Systems (RRWDS) will be installed at ARTCCs to provide color displays of weather data to CWSU personnel. Each RRWDS will have up to twelve different processors - one for each of the possible weather radars that can be hard-wired to RRWDS. East of the Rockies, NWS radars will be the source of weather data; over the Rockies and to the west of them, some ARSRs will be used. RRWDS will provide two or three situation displays (color) at each CWSU. RRWDS will be able to store the weather pictures for all of the twelve surveillance sites. One display will be able to be switched to receive data from any one of the sites. The other display will be able to receive data, through dialup telephone, from any one of the weather radar sites in the country. This data picture will then be stored and displayed.

Later in the Near Term, En Route Weather Display Systems (EWEDS) will replace RRWDS in all ARTCCs. (RRWDS will be moved to Flight Service Facilities.) EWEDS will be installed at ARTCCs to provide color displays of weather data to sector controllers. Each EWEDS will have a single processor (instead of the multiple processors in RRWDS) to receive, process, store and display surveillance data from as many as twelve surveillance sites. It will drive 10 inch (vertical) Sector Weather Displays (color). Controllers at each sector position will be able to control the data displayed at that position. They will be able to select any of the surveillance sites, change range, and change offcentering for their display.

In the Near Term, Dual Common Digitizers (CD-2s) are expected to be available at en route surveillance sites. In addition to improving reliability through redundancy, they would provide improved weather data for display on PVDs.

2.1.2.3 Far Term Improvements

ETABS

In the Far Term, ETABS (Electronic Tabular Display Subsystem) is expected to be implemented. The primary purpose of ETABS is to improve controller productivity in ARTCCs. ETABS would replace the Flight Strip Printers, the Computer Entry Devices at "A" and "D" Positions, and the Computer Readout Devices at "A" and "D" Positions.

In the present en route system, controllers handle flight progress strips and enter messages into the computer via

keyboards and trackballs. ETABS would:

1. Eliminate flight progress strips,

2. Provide controllers with easier methods of entry of flight data,

3. Allow controllers to have easier methods of control and greater control of the display of flight data,

4. Provide displayed data in a wider range of more usable formats,

5. Provide more timely information (flight data and other) to controllers,

6. Display alphanumeric weather data, including routine information and alerts, and

7. Provide substantial support to sector operations when the CCC (Central Computer Complex) is not operational. The support function would:

   a. Receive, store, and process data in such a way as to allow controllers to:

      (1) Update displayed flight data,

      (2) Perform intra-center handoff actions, and

      (3) Request and receive flight plan readouts.

b. Allow the results of such controller actions to be forwarded to the CCC when it resumes operation,

c. Allow the updating of flight data by ETABS, and

d. Allow the routing of information among sectors to be performed by ETABS.

All of the inputs to ETABS would come from within the ARTCC:

- flight plans, flight data, other data. Entered by controllers and/or obtained from the CCC through the Data Entry and Display Subsystem.

All of the outputs from ETABS would go to equipment within the ARTCC:

- displayed, sequenced flight data entries. Used by "D" Controllers.

- displayed menus of potential messages (e.g.: Departure, Hold, Cancellation) and message components (e.g.: altitudes, fixes). Used by "D" Controllers to enter messages.

- up-to-date flight data. To be provided to the CCC if needed after the CCC has been down.

Surveillance Data Input Equipment

It is expected that the broadband surveillance data

communication capabilities will be eliminated in the Far Term. Elimination will be contingent upon the availability of acceptable digital weather data, dual Common Digitizers (CD-2), and the implementation of the currently planned DARC enhancements.

Weather

It is expected that the CWSU will be enhanced in the Far Term. The WBRRs would receive three-dimensional weather data from NEXRAD (Next Generation Weather Radar) sites, and the Service A teletypewriters would be replaced with higher speed communication through NADIN (National Airspace Data Interchange Network).

Improved display of ARTCC weather would also be available through the three-dimensional, digitized, Doppler weather data that is expected to be obtained from NEXRAD. Digitized weather data, including data on areas of turbulence as well as areas of precipition, would also be obtained from NEXRAD. According to current concepts, the turbulent area information would be displayed as hazardous area contours on PVDs and supplementary information would be displayed on EWEDS displays.

2.1.2.4 Potential and Longer Range Improvements

ETABS

Possible methods of backing up ETABS are being investigated. Also, the interfacing of ETABS with DARC and/or adjacent ARTCCs is being considered. With such an arrangement, the effects of

failures in the ARTCC's CCC and/or Data Entry and Display Subsystem might be minimized.

Sector Suite

Enhancement of the "R" Position Console is being considered as a potential improvement in this area. A capability similar to that provided to the "D" Positions through ETABS is favored. The use of tabular display panels with touch input capabilities and the use of color cathode ray tubes instead of the present monochromatic tubes at the "R" Position have been the subject of recent investigation and experimentation. Preliminary efforts are also underway on an overall design of the sector suite including ETABS and the "R" Position Console.

Weather

It is expected that after the 9020 Replacement system is in place, extensive use (on ARTCC situation displays) will be made of three-dimensional weather data and multiple contour (levels of weather intensity) data that would be available.

Weather data that can be observed by an aircraft may be down-linked from the aircraft via DABS Data Link. That data would then be used in weather status and forecasting programs.

The Aviation Weather System (AWES) is a potential integrated weather capability. Since the AWES concept is still under study, the plans for AWES are very tentative. The following is a brief description of this proposed capability. The CWSU at each ARTCC would become the focal point for all weather

information for the Center area. The CWSU would receive PIREPs from ARTCC controllers or from pilots. The CWSU would receive the rest of its information from the Center Weather Processing Complex (CWPC). The CWPC would consist of the FSDPS augmented with additional data processing equipment and of a new radar data processing capability for NEXRAD data. The CWPC would receive weather information from many sources and would make graphic and alphanumeric information available to the CWSU. CWSU personnel would analyze the information and would prepare weather advisory information in alphanumeric and graphic (PVD) form. This would be sent to the CWPC for distribution to aircraft (via the DABS Data Link Applications Processor), to ARTCC sector controllers (via the 9020, 9020R, and/or ETABS), and to TRACONs and Towers (via TIDS). No decision has been reached as to the method by which CWSU personnel would send graphic data to controllers' situation displays in ARTCCs and TRACONs. The Tower and TRACON weather processing functions would be part of TIDS.

2.1.3 Processing and Display of ATC and Related Data

This section and the following sections are concerned with the software functions that process data within the ARTCC, as opposed to the equipment used for input, output, and processing. The latter subjects were discussed in the previous two sections (2.1.1 and 2.1.2).

2.1.3.1 Current System

Flight Data Processing

Currently, Flight Data Processing is performed automatically in the CCC. This function collects and processes Flight Plans and related data so as to provide information to controllers and to other processing functions (e.g., Flight Plan Aided Tracking, Conflict Alert). Processed flight data information is printed on flight progress strips, displayed on Computer Readout Displays, and sent to adjacent facilities (ARTCCs, TRACONs, etc.). Flight Data Processing includes:

- the acceptance and processing of flight data entered from within the ARTCC and from remote locations
- the storage and processing of pre-filed flight plans, and making such flight data available at the correct chronological time
- the preparation of fix time calculations
- the storing and readout, upon request, of selected weather observations, altimeter settings, etc.

Flight data processing includes the checking and conversion of filed routes of flight that are contained within flight plans. It must process many varieties of routes (from random direct routes to highly structured, pre-stored routes) so as to provide check points and calculated times of arrival for use by controllers and by other software functions.

2.1.3.2 Near Term Improvements

DARC

There are a number of Near Term DARC enhancements that would provide improved backup display capabilities to controllers. Specifically, automatic tracking and surveillance data mosaicking should significantly aid controllers.

Maintenance

Remote Maintenance Monitor System (RMMS) data will be available from RCAG equipment and VORTAC equipment. Such data will be received and processed by the Maintenance Processor System at each ARTCC. Further information on this subject is available in 2.1.2.2.

Flight Data Processing

Current plans do not provide for any specific changes in the automated Flight Data Processing function for the Near Term.

2.1.3.3 Far Term Improvements

DABS/ATARS/DABS Data Link

DABS/ATARS data from selected Terminal Surveillance Sites is expected to be available for use at some ARTCCs. DABS Data Link services will not be provided to the ARTCCs by terminal DABS sites except for ATARS related messages. Interfaces and display formats will be designed for the ARTCC to handle surveillance

and ATARS data from Terminal DABS Sites. Decisions have not been made as to whether or not Terminal DABS Sites will be interfaced with ARTCCs and whether or not data from those sites will be displayed to en route controllers. However, for the purposes of this document, it has been assumed that both the interfacing and display capabilities will be implemented.

ETABS

In the Far Term, the expected implementation of ETABS will provide some flight data processing capability -- especially in its role as backup to the CCC. (See 2.1.2.3 for further information on ETABS.)

Maintenance

RMMS data for En Route Surveillance Sites would be available for processing by the Maintenance Processor System at each ARTCC.

FDEPs, FDIOs, and TIDS

In the Far Term, ARTCCs would interface with TIDS (Terminal Information Display System) at some TRACONs (Terminal Radar Approach Control, IFR Room). Flight progress strips would not be prepared for TIDS-equipped TRACONs. TRACONs/TRACABs receive flight progress strips (via FDEPs in the Current system; FDIOs in the Near Term system) and flight plans (via the terminal computer - ARTS III or ARTS II) from their host ARTCCs. The ARTS computers are only sent flight plans for those aircraft that are to arrive or depart within the next few minutes. In the Far Term, it is expected that ARTCCs will send flight data

to TIDS-equipped TRACONs as much as two hours in advance of the scheduled arrivals or departures.

2.1.3.4 Potential and Longer Range Improvements

AERA

AERA (Automated En Route Air Traffic Control) is an advanced air traffic control capability that is currently under development. The following brief description is based on Reference 2-32.

Two of the most important ways in which AERA's capabilities differ from the capabilities of the current ATC system are:

- Overall, integrated planning and monitoring of each individual flight. The AERA planning process approaches a *complete*, *beginning-to-end*, *automated* planning and monitoring of each flight. The process would minimize in-flight changes and provide a conflict-free path.

- Overall, integrated planning and monitoring of the three-dimensional flow of all air traffic in an AERA planning region. The planning and monitoring would provide metered, conflict-free flow using flight plan, surveillance, wind, weather, and aircraft data.

AERA would:

- Perform routine aircraft separation. This would be done with minimum deviation from the desired flight plans. It would continuously project flight plans 10 to 30 minutes

into the future. Within these projections, it would look for delays and conflicts that have high probabilities of occurring and would plan solutions for such situations.

- Control routine traffic flow. This would include the automatic apportioning of delays and the automatic limiting of the incoming traffic flow to AERA planning regions. Such regions would consist of a number of sectors.

- Generate, deliver, and acknowledge routine clearances.

- Allow controllers to be ATC managers. They could check the routine AERA ATC processing and intervene when they wish, rather than be constantly engaged in routine work.

- Automatically adjust all affected flight plans and clearances to changed situations. It would adjust to the unexpected deviation of a single aircraft or to general changes such as airport runway closures, severe weather, or malfunctioning of navigation equipment.

- Generate and transmit flow control requests to adjust facilities and/or the national flow control system. It would also accept and act upon flow control requests from adjacent facilities and the national flow control system.

- Require no special avionics equipment.

The use of AERA should allow:

- o Widespread use of direct routes and fuel-efficient altitude/speed profiles (departure, cruise, arrival).

- o An increase in controller productivity. A controller would not have to:

  - Plan and implement efficient conflict resolutions.

  - Transmit clearances and receive acknowledgements.

  - Handle as many transfers of responsibility (handoffs), since AERA would reduce the number of sectors per ARTCC.

- o A reduction in the number of System Errors (observed violations of ATC separation standards). The reduction should occur as a result of controllers being relieved of routine functions.

- o Aircraft/Air Crew/Air Carrier users to file requests for specific detailed altitude/speed profiles, or general (horizontal) routes. AERA would accommodate the users to as large an extent as possible, but in any case, would provide routes and profiles tailored to the aircraft and the environment.

- o A decrease in procedural limitations in the use of airspace. In today's ATC system, there are procedural restrictions that keep aircraft at inefficient low

altitudes or on circuitous routings. These procedures are pre-arranged among ATC facilities to ensure that potentially conflicting traffic flows will always be separated, either laterally or vertically, after allowing for a range of individual deviations. Since the flows are separated, limited deviations need not be dealt with, and individual clearances need not be coordinated with other ATC sectors or facilities. The limiting factor that leads to the imposition of procedural restrictions is the controller's capacity to coordinate clearances - not the saturation of airspace with aircraft. Therefore, a more automated process for coordinating individual flight clearances should greatly reduce the need for rigid flow restrictions. Only isolated "hot spots" that are not amenable to reliable automated conflict resolution would have procedural restraints.

The implementation of the full capabilities of AERA is contingent upon the replacement of current en route computers, since they do not have the capacity to handle all of the AERA functions. However, many of the AERA functions would be useful in the current National Airspace System, and could be implemented in augmentation processors attached to the current NAS.

ATARS/DABS Data Link

A longer range improvement is the availability of ATARS data from En Route Surveillance Sites. A brief description of ATARS can be found in 2.1.4.4. Further information on the subject can

be found in 3.1.4. DABS Data Link capabilities would be available to the ARTCC in connection with the implementation of DABS/ATARS. A description of these capabilities can be found in 2.1.5.4.

2.1.4 Aircraft Separation Services

2.1.4.1 Current System

Conflict Alert

Currently, through Conflict Alert, controllers are provided with warnings of potential conflicts between all tracked aircraft in the system. The Conflict Alert function, and the inputs and outputs for that function, are contained within the CCC. Alerts can result from the present positions or predicted future positions of aircraft. Alerts are displayed to appropriate controllers. Controllers determine their own solutions to conflict situations with virtually no automation aid.

2.1.4.2 Near Term Improvements

Conflict Alert

Current plans call for the addition of an IFR/VFR Conflict Advisory Function in Conflict Alert in the Near Term. This function would provide automatic detection of immediate potential conflicts between a normally tracked aircraft and a Mode C equipped VFR intruder aircraft.

Conflict Resolution Advisory

In the Near Term, it is expected that the Conflict Resolution Advisory function will be available to aid controllers in resolving many of the aircraft conflicts predicted by the Conflict Alert function. The Conflict Resolution Advisory function would provide resolution advisory service for potential conflicts. All of the inputs to the Conflict Resolution Advisory function would come from information in the ARTCC's data base. Aircraft positional information would come from the Automatic Tracking function. Indications of potential conflicts would come from the Conflict Alert function. Resolution advisories, the outputs of the Conflict Resolution function, would be displayed to appropriate controllers.

Active BCAS

Active BCAS (Beacon Collision Avoidance System) is an improvement related to Conflict Alert that is expected to be accomplished through systems that would not be contained within ARTCC buildings. It is mentioned here because of its relationship with Conflict Alert. Active BCAS is planned for implementation in the Near Term. BCAS would serve as a backup to the Conflict Alert capability provided by ARTCCs. It is anticipated that BCAS avionics would be installed in most air carrier and high performance general aviation aircraft. BCAS is an airborne collision avoidance system that would function through replies that it would receive from DABS and ATCRBS (Air Traffic Control Radar Beacon System) transponders on other aircraft. It would use these inputs to calculate range, relative altitude, and closing rate information in relation to

the other aircraft that are possible collision threats. When the projected time to collision is about 30 seconds, BCAS would indicate recommended avoidance maneuvers on a display in the cockpit of the BCAS-equipped aircraft. More detailed information can be found in 3.1.4.

2.1.4.3 Far Term Improvements

No direct Far Term en route improvements in Aircraft Separation Services are planned for the Far Term. Indirect improvements in this area may be available through the ATARS data that is expected to be available from selected Terminal Surveillance Sites. ATARS (Automatic Traffic Advisory and Resolution Service) would be installed at Terminal DABS Sites in the Far Term. Terminal ATARS is being designed to provide ATARS services to selected adjacent ARTCCs. The specific en route processing and display of such data have not been determined.

2.1.4.4 Potential and Longer Range Improvements

ATARS

ATARS is a backup collision avoidance capability that as currently planned, would not have any portions of its hardware or software housed in ARTCC buildings. It is mentioned here because of its relationship with Conflict Alert. DABS and ATARS are expected to be implemented at En Route Surveillance Sites after replacement of the en route ATC computers. There, they will provide more extensive ATARS service to ARTCCs. ATARS would track target data obtained from DABS and check projected aircraft positions for closeness to one another. When

appropriate, ATARS would prepare warning messages and recommended resolution maneuvers for uplinking to DABS/ATARS-equipped aircraft through DABS Data Link (see 2.1.5.4). The information could be displayed to the pilot on an ATARS display in the cockpit. This information could also be sent to TRACONs and ARTCCs for display at appropriate sector positions. More detailed information on ATARS can be found in 3.1.4.

AERA

AERA would provide aircraft separation services. It has been described in 2.1.3.4.

BCAS

Full BCAS is a potential backup aircraft separation service. It is a more sophisticated version of Active BCAS (see 2.1.4.2). A more detailed description of Active and Full BCAS can be found in 3.1.4.

2.1.5 Communication with Aircraft

2.1.5.1 Current System

Currently, controllers send and receive much information through voice radio (UHF and VHF) connections with aircraft.

2.1.5.2 Near Term Improvements

No Near Term changes are included in the current plans.

2.1.5.3 Far Term Improvements

No Far Term changes are included in the current plans.

2.1.5.4 Potential and Longer Range Improvements

DABS Data Link and CMA (Control Message Automation) are longer range improvements. DABS Data Link is being planned and designed as a supplement to the voice radio capabilities. Many routine and high-priority messages could be transmitted via Data Link. CMA would provide the link between the ARTCC (the controllers and automated functions) and the Data Link processing capabilities at the DABS site. CMA would handle functions such as formatting, internal management of records and messages, and the establishment and use of priorities for data link messages. CMA would handle messages that may be generated through functions/features such as Altitude Assignment, Frequency Assignment, AERA, and EMSAW. Conflict Resolution Advisory, ETABS, etc. Work is underway in these areas, but the overall use of DABS Data Link for communication between ARTCCs and aircraft has not been determined.

2.1.6 Detection of Unsafe/Unacceptable Use of Airspace

2.1.6.1 Current System

Currently, EMSAW (En Route Minimum Safe Altitude Warning System) uses computer software to automatically compare reported aircraft altitudes to minimum safe altitudes in order to detect instances in which an aircraft is now, or in the near future will be, below a minimum safe altitude. EMSAW warns a

controller of such a situation through information displayed on the controller's PVD. The controller then advises the aircraft air crews of the situation through voice radio.

2.1.6.2 Near Term Improvements

No Near Term improvements are currently planned.

2.1.6.3 Far Term Improvements

No Far Term improvements are currently planned.

2.1.6.4 Potential and Longer Range Improvements

ATARS Avoidance Advisories

Additional capabilities for detecting unsafe or unacceptable use of airspace are expected to be implemented as part of ATARS. These would provide pilots and controllers with real-time messages that would allow aircraft to avoid:

- o Terrain (hills, valleys, sloping land),
- o Obstacles (TV towers, microwave relay towers, radio towers, tall buildings), and
- o Special Airspace (Terminal Control Areas, Restricted Airspace, Prohibited Airspace).

The avoidance information would also be needed by ATARS in order to prevent collision avoidance resolution advisories from being

given that would maneuver aircraft into terrain, obstacles, or special airspace. Preliminary investigations of these functions have been made.

AERA

AERA would incorporate monitoring of aircraft as to their occupation of airspace that is acceptable as to altitude and other restrictions. More detailed information on AERA can be found in 2.1.3.4.

DABS Data Link

A potential improvement that is being considered is the use of DABS Data Link to uplink ATARS Terrain, Obstacle, and Special Airspace Avoidance Advisories and/or EMSAW Avoidance Advisories to aircraft.

2.1.7 Traffic Flow Management

Local Flow Control

Local Flow Control is concerned with the general flow of traffic within an ARTCC's boundaries. Local Flow Controllers monitor events that may cause marked increases or decreases in traffic flow in particular areas. When warranted, they take actions to adjust the resources of the ARTCC to these events. Examples of events that are looked for, are: severe weather in an ARTCC area, an unusually large gathering of people for a special event (e.g., sporting event, political meeting, business convention), and a current or future buildup of traffic within specific

sectors. Actions that can be taken include: changing the flow of traffic, changing sectorization, distributing ATC-caused delays equitably among aircraft, and arranging for additional controllers to be available to handle heavy predicted loads.

En Route Metering

En Route Metering organizes the flow of en route traffic bound for terminal areas. The objective of the En Route Metering Function is to deliver aircraft to terminal feeder fixes at those times that will provide the following features to as large an extent as possible without compromising safety:

a. Satisfaction of the TRACON's required acceptance rate,

b. Conservation of fuel through the use of delay absorption methods (i.e., speed reductions and idle thrust descents) and transferring major delays to high altitude airspace,

c. Equitable distribution of ATC-caused delays (including previous delays in the air and on the ground) among the various flights, and

d. Minimum congestion and noise in and around terminal areas.

Two levels of automation have been identified in this area:

- En Route Metering I. This is the package specified by Configuration Control Directive 4319.

- o En Route Metering II. This is the package specified by "En Route Metering Functional Specification" of September 1980 (Reference 2-7).

2.1.7.1 Current System

En Route Metering

With the exception of the Fort Worth and Denver ARTCCs, metering is currently performed manually by metering position personnel or by individual sector controllers. They plan the delivery of arrival flights to terminal feeder fixes to satisfy the TRACON's desired acceptance rate (where acceptance rate may be related to airways or the entire TRACON airspace).

En Route Metering I is operational at Fort Worth and Denver, and will be implemented nationally early in the Near Term. As indicated in Reference 2-7, this capability provides:

1. Acceptance rate metering to one or more airports so as to schedule flights for delivery to a merge point with a uniform time separation to match the acceptance rate specified by the airport,

2. Tabular displays at one or more Metering Positions to present such information as meter fix crossing times and calculated landing times,

3. Tabular displays at the arrival sector R-positions to present the time at which each metered flight should cross its meter fix (and the estimated delay to meet that time),

4. A repertoire of Metering Position input actions which allow the controller to enter data such as the airport acceptance rate and the runway configuration in use at the metered airport.

2.1.7.2 Near Term Improvements

Local Flow Control

No direct improvements in Local Flow Control are currently planned for the Near Term. However, indirect improvements will be available through En Route Metering II (see below). That function will simplify Local Flow Controllers' work because of its organization and smoothing of traffic flow to terminal areas.

En Route Metering

En Route Metering II will be implemented in the Near Term. As indicated in Reference 2-7, it will expand upon the functional capabilities provided by En Route Metering I. The major additions will be:

1. The generation and display of advisories to the controllers suggesting how the required delay may be taken in a fuel-conservative manner, in addition to advising the controller of the amount of required delay associated with the suggested advisory. The types of advisories generated are outer fix advisories, speed reduction advisories, descent control advisories, and holding advisories,

2. The generation and display of metering advisories to

R-Controllers at sectors upstream from the arrival sectors, so as to provide more system response time for the absorption of metering-related delays,

3. An expanded repertoire of Metering Position input actions to allow the selection of the delay absorption strategies to be in effect at any given instant and to permit a greater degree of control over the metering process, and

4. A capability for extending the automated metering process beyond the individual center boundaries via the existing computer-to-computer interface for the exchange of metering-related data. (i.e., outer fix advisories and inter-center radar track updates).

2.1.7.3 Far Term Improvements

Local Flow Control

No direct improvements in Local Flow Control are currently planned for the Far Term. However, indirect improvements may be available through the automated ARTCC-TRACON interface described in the next paragraph. The interface would aid the metering process and thus simplify Local Flow Controllers' work.

En Route Metering

In the Far Term, an automated interface would be provided between En Route Metering and Terminal Sequencing and Spacing so as to allow the exchange of metering data. This data would

include such real-time information as runway acceptance rates, runway slot usage, or flight data for specific terminal flights.

2.1.7.4 Potential and Longer Range Improvements

AERA

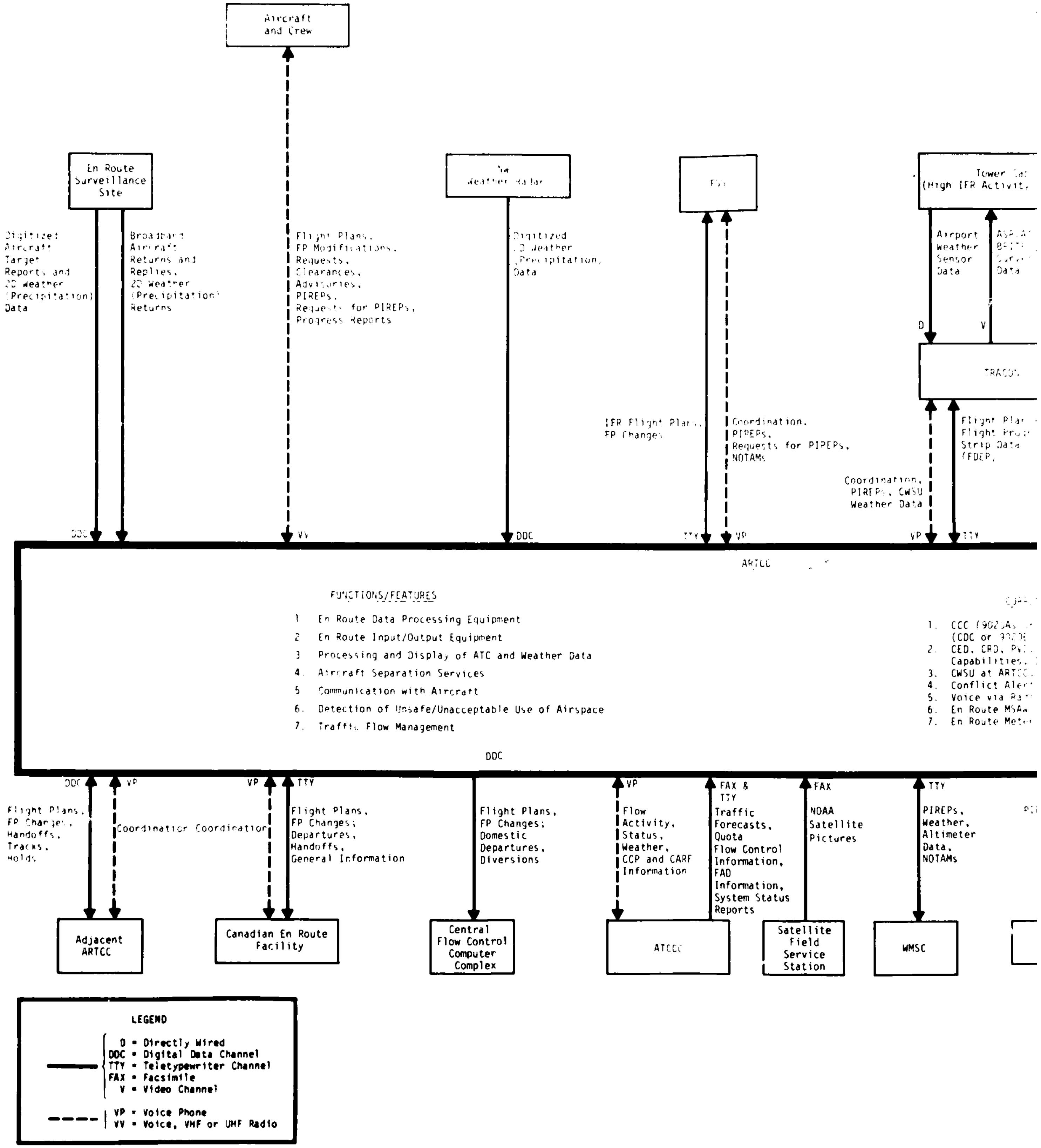
A longer range potential improvement affecting this area is AERA. This function would solve routine spacing and sequencing problems and implement the solutions through automatically-generated messages sent to pilots via Data Link or voice radio. AERA would significantly aid or replace the Local Flow Control function and would include the capabilities of En Route Metering among its functions. (See 2.1.3.4 for further information on AERA.)

Integrated Flow Management

Integrated Flow Management (IFM) is a concept that may be implemented as a longer range improvement. IFM is a planning process that would provide for communications and coordination among the various ATC facilities (Central Flow Control, En Route, TRACON, Tower Cab) to assure the efficient utilization of existing resources to meet the demand imposed on the ATC system. It is concerned with a coordinated and efficient systemwide operation and does not exercise any direct control of individual aircraft. Preliminary work is underway on IFM.

2.2 En Route Facilities Connectivity

Figures 2-4, 2-5, and 2-6 show respectively, the Current, Near



Aircraft and Crew
En Route Surveillance Site
Weather Radar
FSS
Tower Cab (High IFR Activity)
Digitized Aircraft Target Reports and 2D Weather (Precipitation) Data
Broadband Aircraft Returns and Replies, 2D Weather (Precipitation) Returns
Flight Plans, FP Modifications, Requests, Clearances, Advisories, PIREPs, Requests for PIREPs, Progress Reports
Digitized 2D Weather (Precipitation) Data
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Airport Weather Sensor Data
D
V
TRACON
Coordination, PIREPs, CWSU Weather Data
DDC
VV
TTY
VP
ARTCC
FUNCTIONS/FEATURES
1 En Route Data Processing Equipment
2 En Route Input/Output Equipment
3 Processing and Display of ATC and Weather Data
4. Aircraft Separation Services
5 Communication with Aircraft
6. Detection of Unsafe/Unacceptable Use of Airspace
7. Traffic Flow Management
3. CWSU at ARTCC
4. Conflict Alert
6. En Route MSAW
DDC
FAX & TTY
FAX
Flight Plans, FP Changes, Handoffs, Tracks, Holds
Coordination
Coordination
Flight Plans, FP Changes; Departures, Handoffs, General Information
Flight Plans, FP Changes; Domestic Departures, Diversions
Flow Activity, Status, Weather, CCP and CARF Information
Traffic Forecasts, Quota Flow Control Information, FAD Information, System Status Reports
NOAA Satellite Pictures
PIREPs, Weather, Altimeter Data, NOTAMs
Adjacent ARTCC
Canadian En Route Facility
Central Flow Control Computer Complex
ATCCC
Satellite Field Service Station
WMSC
LEGEND
D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
FAX = Facsimile
V = Video Channel
VP = Voice Phone
VV = Voice, VHF or UHF Radio

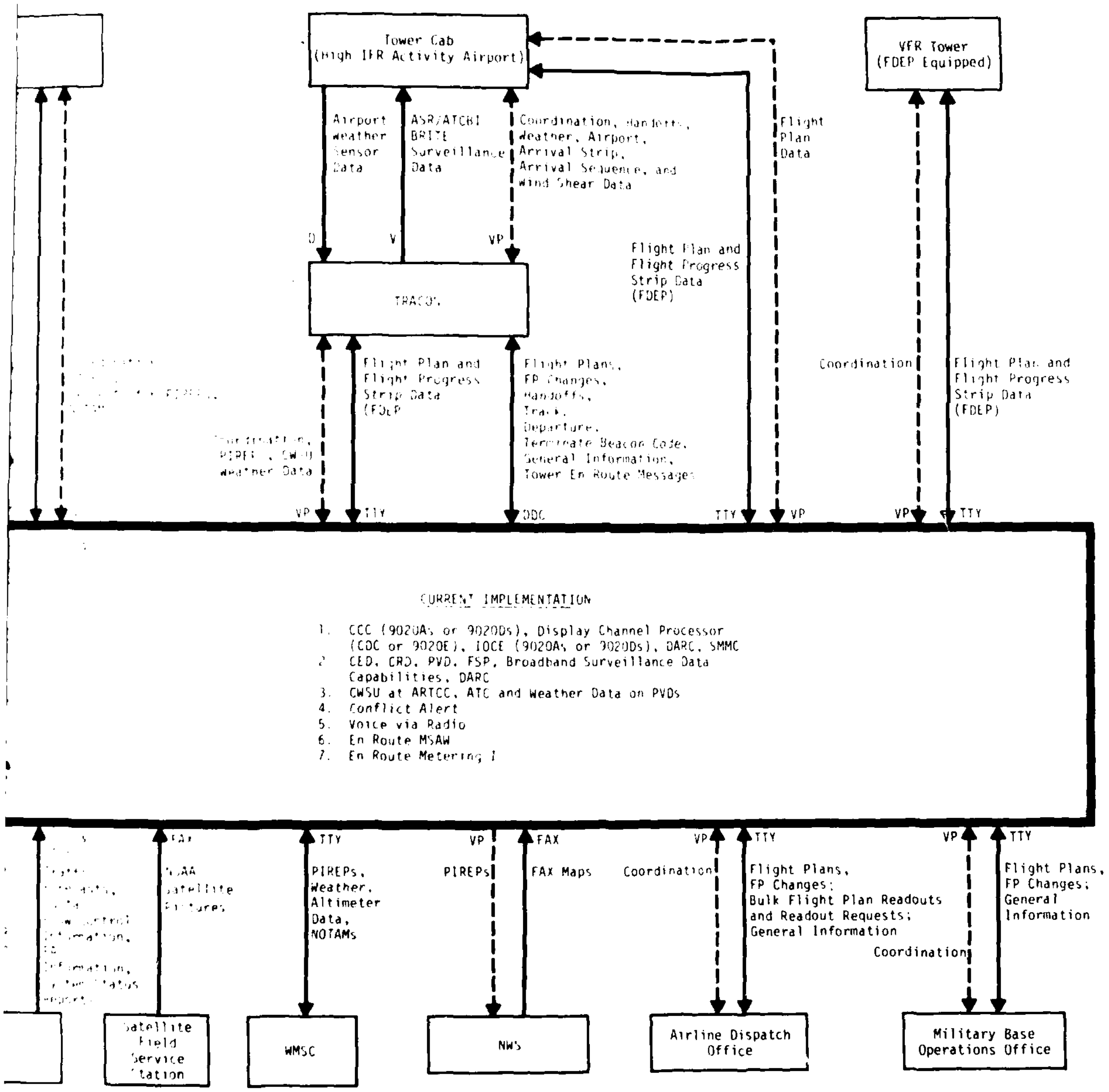
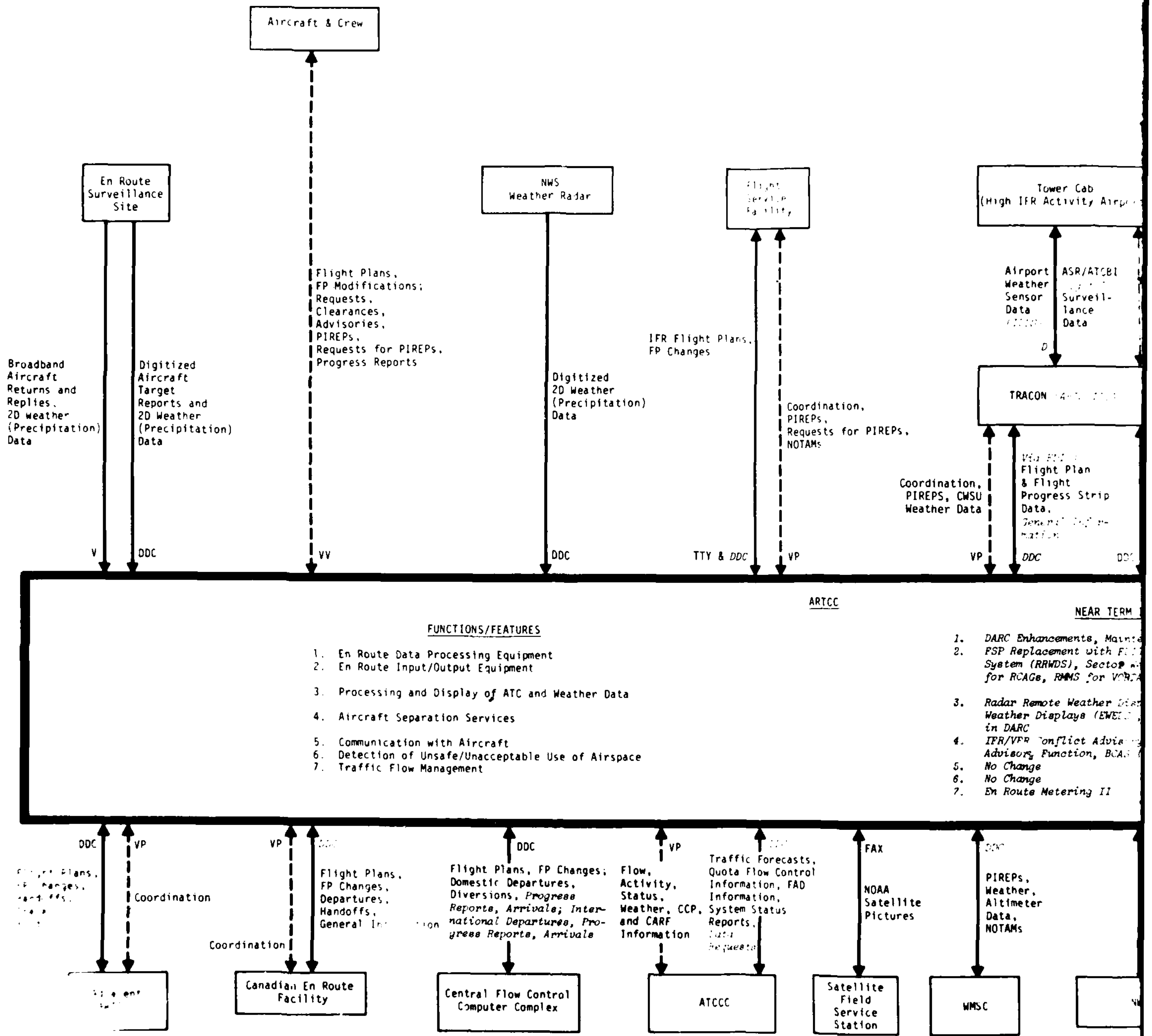


FIGURE 2-4
CURRENT ARTCC CONNECTIVITY DIAGRAM

2



the current system to the
indicated in italics

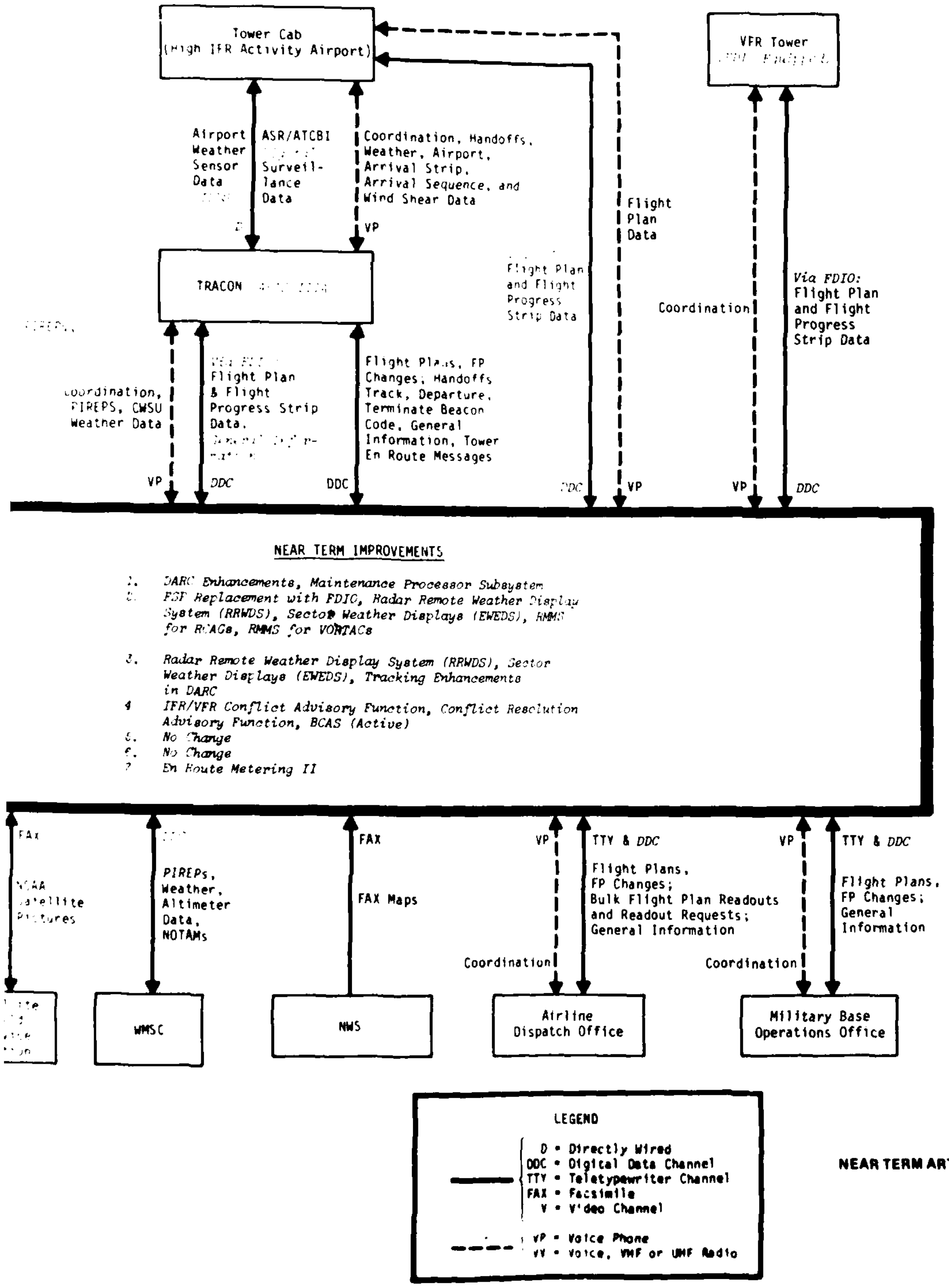
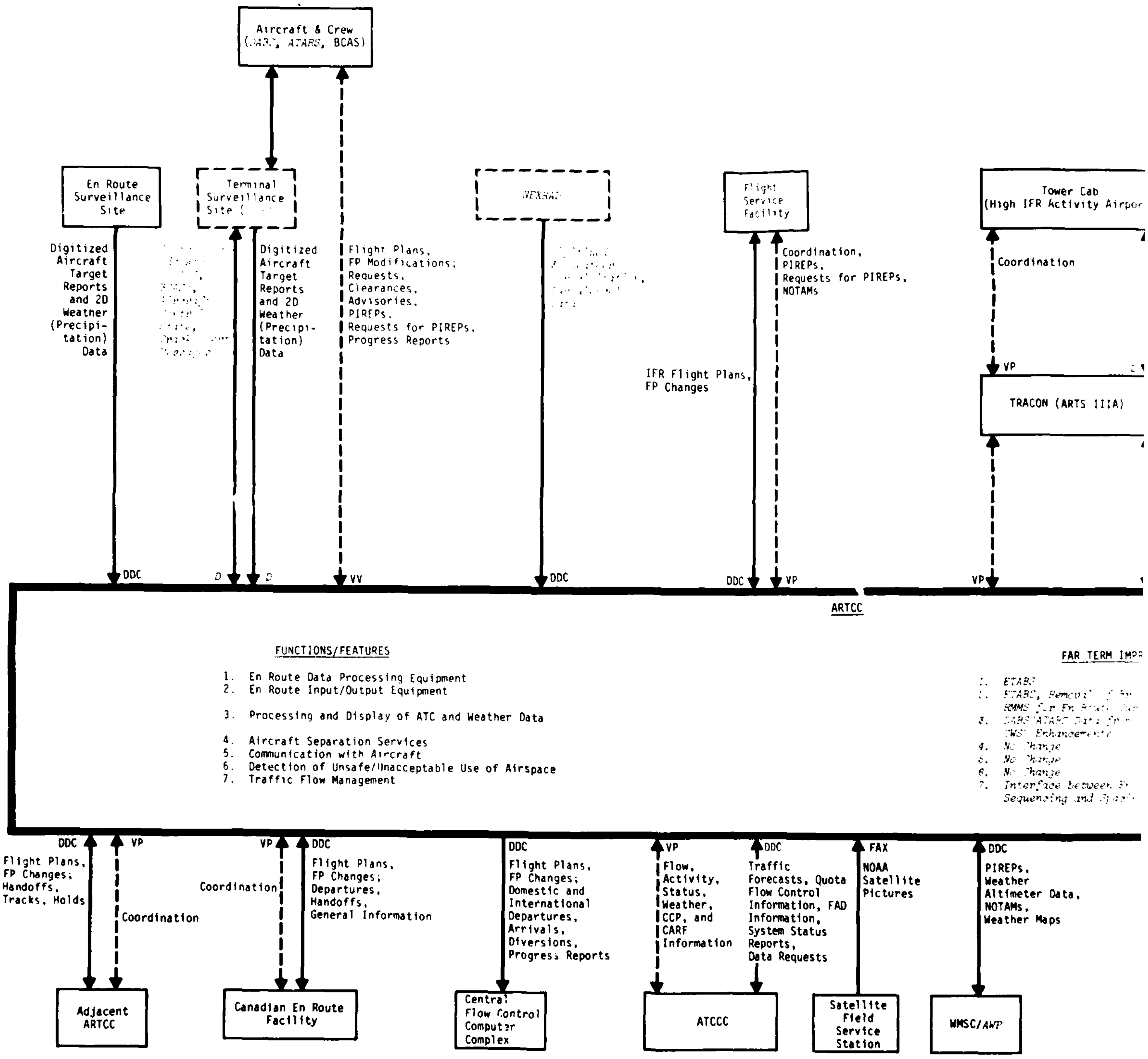


FIGURE 2-5
NEAR TERM ARTCC CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

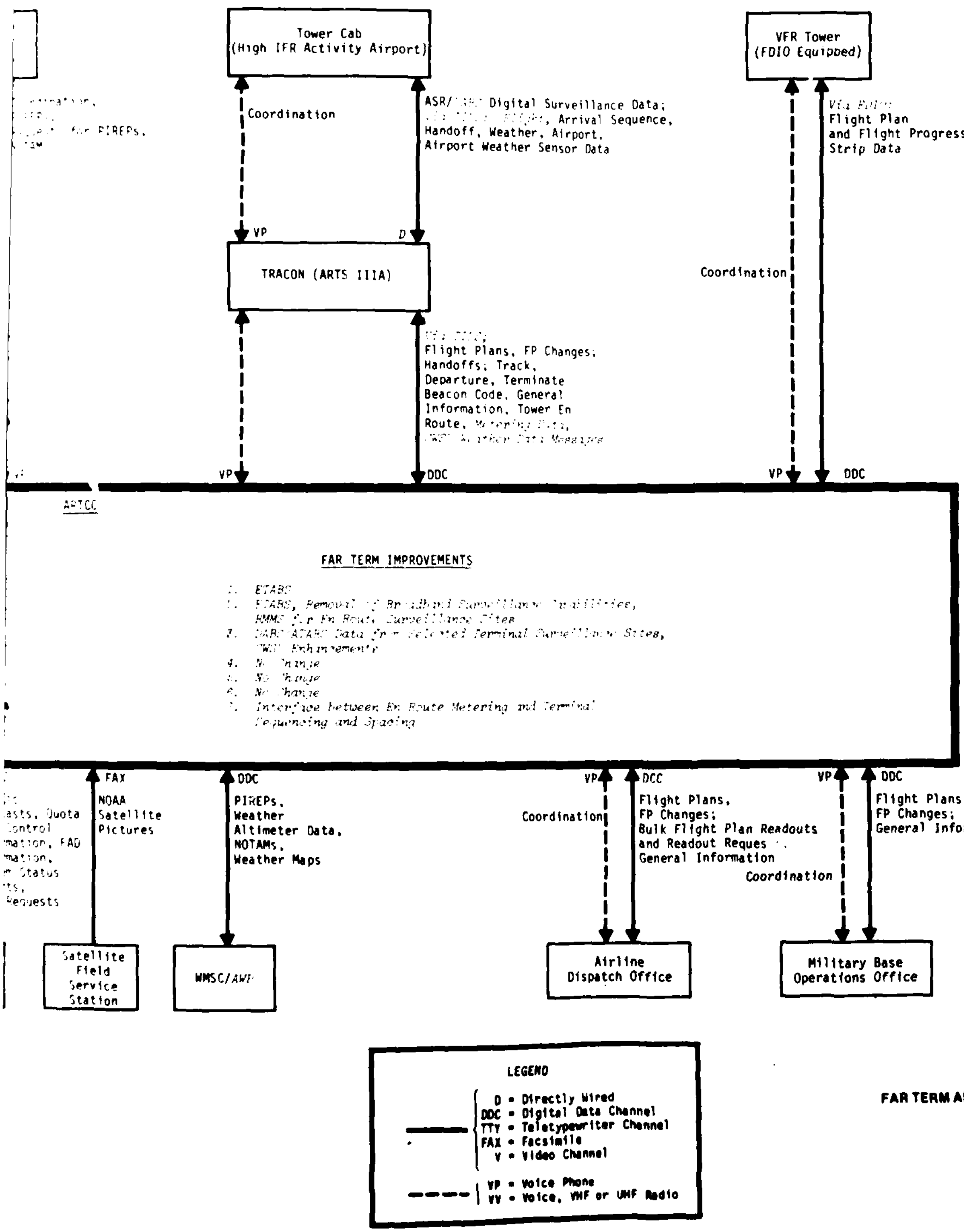


FIGURE 2-6
FAR TERM ARTCC CONNECTIVITY DIAGRAM

Term, and Far Term connections between an En Route Facility (ARTCC) and other elements of the ATC system. The principal changes in connectivity from the Current System to the Near Term System are shown in italic type in Figure 2-5. Changes in complete functions and groups of improvements are further emphasized by being enclosed in blocks outlined with heavy, broken lines. Similarly, italics and heavy, broken lines are used in Figure 2-6 to indicate the principal changes in connectivity from the Near Term System to the Far Term System. These changes are briefly described in the following paragraphs.

Near Term

The ARTCC will communicate with Flight Service Facilities (Flight Service Stations (FSS), Automated Flight Service Stations (AFSS), and Flight Service Data Processing Systems (FSDPS)) rather than just Flight Service Stations. The ARTCC's communication with TRACONs and Towers via FDEP equipment will be changed to higher speed communication via FDIO equipment.

Additional domestic and international flight movement information would be sent to the ATCCC from the ARTCC for use in Central Flow Control calculations. Data requests to the ATCCC could be made directly over 2400 bps channels from DTEs at the ARTCCs; responses can be received in the same manner. Line speeds would be increased for communications between the ARTCC and Canadian En Route Facilities, the ATCCC, WMSC, and some Flight Service Facilities, Airline Dispatch Offices, and Military Base Operations Offices. FSPs in the ARTCC will be replaced by FDIO printers. The Maintenance Processor Subsystem (MPS) would provide remote monitoring and certification of RCAGs

and VORTACs via Remote Monitoring Subsystems at these facilities.

Except as noted above, the following improvements are internal to the ARTCC and would cause no significant changes in connectivity: DARC Enhancements, addition of Radar Remote Weather Display System (RRWDS), addition of Maintenance Processor Subsystem, addition of Sector Weather Displays (EWEDS), IFR/VFR Conflict Advisory function, Conflict Resolution Advisory function, and En Route Metering II.

Far Term

In the Far Term, the broadband surveillance data would be eliminated. It would no longer be needed once the currently planned DARC enhancements are implemented, dual Common Digitizers (CD-2) are implemented, and acceptable digital weather data is available. Digitized three-dimensional weather data that includes data on areas of turbulence in addition to areas of precipitation, would be received from NEXRAD sites. Some terminal surveillance sites would provide the ARTCC with information concerning ATARS warnings and ATARS recommended maneuvers that have been sent to aircraft. The CCC in the ARTCC will communicate with Automated Flight Service Stations, the FSDPS in the ARTCC, and other FSDPSs. RMMS would be provided with the additional capability of remote monitoring and certification of En Route Surveillance Sites. The capability of CWSUs would be improved. The ARTCC would no longer send flight progress strip data to FDEPs or FDIOs in some TRACONs. Instead, TIDS would use the Flight Plans that it receives from the ARTCC to prepare flight progress data to be displayed to Tower Cab and

TRACON/TRACAB controllers. PIREPs (Pilot Reports) and Requests for PIREPs from the Aviation Weather Processor (AWP) would be sent through NADIN digital data communication channels instead of by voice. An automated interface would be established between En Route Metering (ARTCC) and Terminal Sequencing and Spacing (TRACON). Except as noted above, the following improvements are internal to the ARTCC and would cause no significant changes in connectivity: ETABS and CWSU Enhancements.

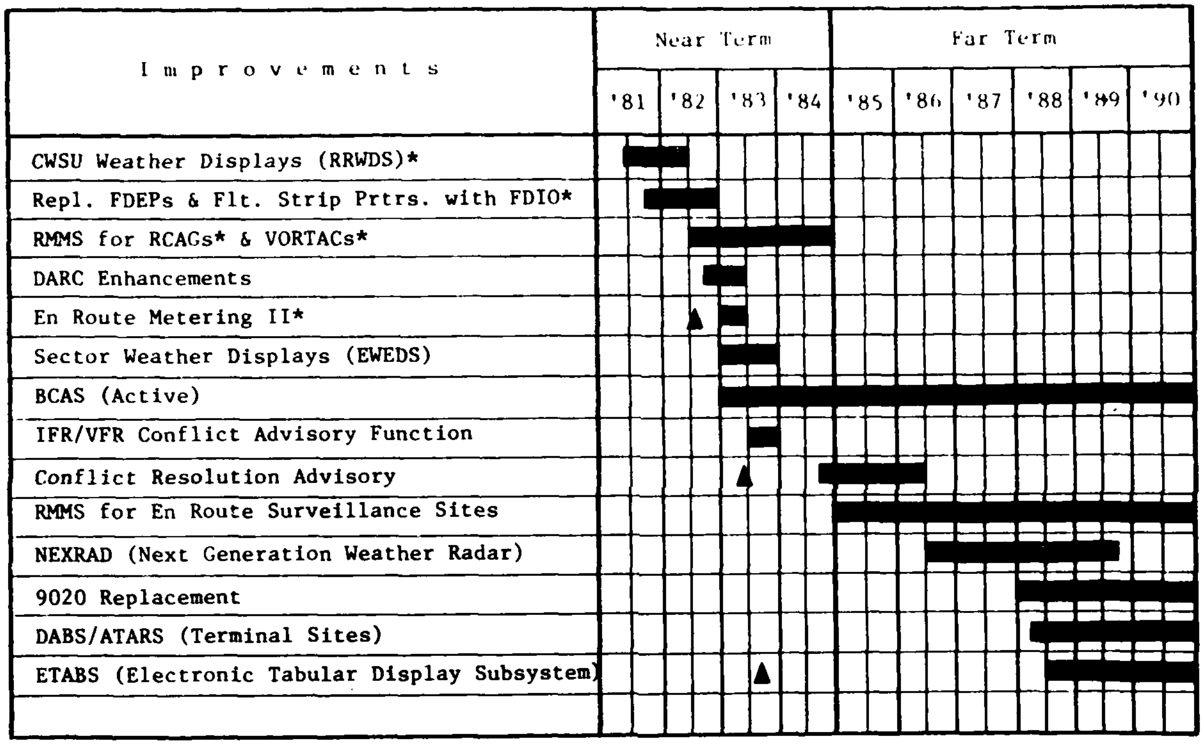
2.3 En Route Facilities Tentative Implementation Schedule

Figure 2-7 shows the tentative implementation schedule for the principal improvements to the En Route Facilities. BCAS and Terminal DABS/ATARS are also included since they are closely related to many ARTCC functions.

Generally, the schedules for implementation are not schedules that have been approved by FAA management. In most cases, no decision has been made to implement the function. The schedules are based on the best estimates of the times of availability of the Technical Data Packages. The estimates have been obtained from personnel who have been working on the specific function as well as from budgetary information.

2.4 En Route Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at an En Route Facility, and how they would interact



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 2-7
EN ROUTE FACILITIES - ARTCC,TENTATIVE IMPLEMENTATION SCHEDULE

with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues".

The Integration Issues cited below were identified during the preparation of this document and were reviewed with the appropriate FAA program managers. Follow-up on these issues was undertaken by a joint Systems Research and Development Service and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in December 1980. The reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions.

The integration issue assumptions pertinent to En Route Facilities are:

2.4.1 Assumptions in Regard to DABS, ATARS, and Data Link

Issue 202: Use of DABS/ATARS Data by En Route and Terminal Automation Facilities

It was assumed that in the Far Term, ATARS Advisories and DABS data will be sent from Terminal DABS Sites to Terminal ATC facilities and to some adjacent En Route ATC facilities. En Route DABS Sites will be implemented as longer range improvements. ATARS Advisories and DABS data will be sent from the En Route DABS Sites to En Route ATC Facilities. En Route and Terminal Automation Facilities will display the received advisories to their controllers.

Issue 706: ARTS Advisories on Non-Mode C Aircraft

It was assumed that proximity advisories will be sent to ATARS-equipped aircraft for target aircraft that are Mode A equipped or are tracked by search radar.

Issue 208: ARTCC Software for Use with DABS

It was assumed that the initial ARTCC software will be able to handle DABS surveillance data, ATARS data, and interfacility control and coordination requirements (e.g., Aircraft Control State). Later software will handle en route surveillance site data.

Issue 204: Use of the DABS Data Link

It was assumed that the first en route use of the data link capability will be to provide altitude assignment confirmation. Other uses will follow.

Issue 205: CMA Development Activities

It was assumed that CMA will be designed and implemented to provide formatting, internal management of records and messages, and the establishment and use of priorities for those data link messages that originate within the ARTCC.

Issue 203: DARC -- CCC -- DABS

It was assumed that in the DABS era, DARC will be modified to provide appropriate control and coordination capabilities when

the CCC is not available.

Issue 702: DABS/ATARS Operational Procedures Description

It was assumed that the subject description will be available to specify the needed design and implementation features.

2.4.2 Assumptions in Regard to Other Issues

Issue 101: Backup ATC Capability in the Event of Catastrophic Failure

It was assumed that no overall backup capability that can take over all of the operations of a failed ARTCC will be implemented until after the 9020 computers have been replaced.

Issue 201: Mode C Intruder Function (Conflict Alert)

It was assumed that since the software to provide this function (IFR/VFR Conflict Advisory) was rewritten, the processing and storage requirements are small enough that this function will be implemented in the Near Term.

Issue 405: Traffic Flow Management

It was assumed that the various advanced systems and automation improvements (e.g., En Route Metering, Terminal Sequencing and Spacing, and Central Flow Control) that are planned for traffic flow management w'll be implemented as compatible packages.

Issue 206: Weather Program Definition

It was assumed that in the Far Term, the CWSU will distribute tabular weather data to TIDS and ETABS for display to controllers. Further assumptions as to the exchange, use, and display of weather data are contained in Issue 207.

Issue 207: En Route Weather Display Concept

It was assumed that controllers will be provided with two-dimensional weather data from WSR-57s on EWEDS 10" (vertical) sector displays in the Near Term. Three-dimensional digitized, Doppler weather data will be available from NEXRAD in the Far Term. Turbulent area information from this data will be displayed as hazardous area contours on PVDs in the Far Term. Extensive use of the three-dimensional characteristics of NEXRAD data will not occur until after the ATC Computer Replacement has been accomplished.

Issue 211: VSCS - 9020 Relationship

It was assumed that a GPI/GPO peripheral adapter module (PAM) will be used to provide the 9020 to VSCS interface. The VSCS will respond to reconfiguration commands generated by the 9020. A VSCS/9020 Interface Control Document (ICD) will be developed by the VSCS contractor. Software changes in the 9020 that are required to establish this interface will be kept to a minimum.

3. TRACON FACILITIES

This chapter describes the system improvements planned for TRACON Facilities and the interfaces with other ATC facilities for Current, Near Term, and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1.

This chapter is concerned with TRACONs (Terminal Radar Approach Control, IFR Room) and TRACABs (Terminal Radar Approach Control Tower Cab). TRACONs are at airports at which approach control is principally performed in an IFR (Instrument Flight Rules) room. Additional approach control work is performed at one or more associated Tower Cabs at major and satellite airports. TRACABs are at airports at which approach control is performed only in the Tower Cab.

The control exercised by TRACON/TRACAB Facilities is generally limited to those aircraft that are operating close to airports but are not under control of a Tower Cab. Tower Cabs are generally in control of aircraft that are within five miles of an airport and are below 3000 feet AGL (Above Ground Level).

Automation Equipment

All TRACONs and TRACABs are now, or in the future will be, equipped with data processing equipment to provide automation of some Air Traffic Control functions. Three general types of automation equipment are used: ARTS (Automated Radar Terminal System) III, ARTS II, and TPX-42.

The emphasis in this chapter will be on TRACONs with ARTS IIIA

equipment and TRACONs/TRACABs with ARTS II equipment. ARTS IIIA configurations provide the highest level of terminal automation. TRACONs and TRACABs equipped with ARTS II or TPX-42 equipment provide many of the same functions as the ARTS III and ARTS IIIA TRACONs but with less sophistication and flexibility. ARTS II is also of particular importance because of the current widespread deployment of ARTS II, the future widespread deployment of ARTS-II-like equipment, and the magnitude of the improvements in ARTS II equipment and software that are expected in the future. Table 3-1 shows a comparison of the features of the various current and future terminal automation systems. Table 3-2 shows the current deployment of automation equipment among the various terminal ATC facilities.

Chapter Content and Organization

Except where otherwise noted, when a TRACON is referred to in the remainder of this chapter, it will denote an ARTS III or ARTS IIIA TRACON. It should, however, be kept in mind that many of the same functions and capabilities will be available with TRACONs and TRACABs equipped with ARTS II or TPX-42 equipment.

Although the basic organization of the information in this volume is by facility, an exception has been made in regard to Aircraft Separation Services. It was felt that the principal descriptions of the various Aircraft Separation Service automated capabilities should not be scattered among several chapters. Since Conflict Alert is already operational at major terminals, and ATARS (Automatic Traffic Advisory and Resolution Service) will have its first implementation at terminal sites, the TRACON chapter contains the principal descriptions of the

AD-A103 241 MITRE CORP MCLEAN VA F/G 1/2

FUTURE ATC SYSTEM DESCRIPTION ATC FACILITIES AND INTERFACES (19--ETC(U)

JAN 81 J H CHILDERS, R C HUNTER, D TUTTLE DOT-FA01-81-C-10001

UNCLASSIFIED MTR-81W6 FAA/RD-81/17 NL

2 OF 5

AD A103241

TABLE 3-1
FEATURES OF TERMINAL AUTOMATION SYSTEMS

Features		ARTS III	ARTS IIIA	ARTS II	ARTS IIA	TPX-42
Automatic Tracking of Beacon Targets		X	X		X	
Automatic Tracking of Search Radar Targets			X			
Automation-aided Non-verbal Handoffs		X	X	X	X	
Exchange of Radar Position and Track Data with Host ARTCC		X	X	X	X	
Controller-enterable Keyboard Messages		X	X	X	X	
Redundant Equipment and Fail-Soft Capability			X			
Multiprocessing Capability			X			
Conflict Alert		X	X		X	
Minimum Safe Altitude Warning System (MSAW)		X	X		X	
Training Target Generator			X		X	
Continuous Data Recording			X			
Information Displayed on Situation Displays	Beacon Replies	X	X	X	X	X
	Search Radar Returns	X	X	X	X	
	Data Blocks Associated with Beacon Replies	X	X	X	X	X
	o 'X' and 'O' Usable As Position Symbols	X	X	X	X	X
	o Other Alphanumeric Characters or Symbols Usable as Position Symbols	X	X	X	X	
	o Aircraft Identification (Call Sign)	X	X	X	X	
	o Assigned Altitude (IFR Flights)	X	X	X	X	
	o Mode C Altitude	X	X	X	X	X
	o Ground Speed	X	X		X	
	Data Blocks Associated with Search Returns		X			
	Tabular Data (e.g.: Arrival/Departure List)	X	X	X	X	

TABLE 3-2
TERMINAL ATC FACILITIES

AIRPORT TYPE		TRACON	TRACAB	TOWER CAB
High IFR Activity Airports (67)		ARTS III Automation (63)	None	67 Airports*
Medium IFR Activity Airports (107)		ARTS II (48)** TPX-42 (11)	ARTS II (20)** TPX-42 (28)	107 Airports
Low IFR Activity Airports	High VFR Activity Airports (222)	None	None	222 Airports
	Medium and Low VFR Activity Airports (10,000 +)	None	None	None

*Several of the high IFR activity airports share a common TRACON, e.g., JFK, Newark, and LaGuardia in New York City.

**Fifteen additional ARTS II sites are to be commissioned early in 1981.

Aircraft Separation Service capabilities - even though ATARS and BCAS are not contained within TRACON rooms.

The remainder of this chapter consists of the following sections:

- o TRACON Facilities Improvements (3.1). This section lists important functions/features and the improvements planned for them. For each function/feature, there is a brief description of the function and the planned improvement(s). The section contains three Information Flow Diagrams -- one for each of the three system phases: Current, Near Term, and Far Term. The diagrams show the facilities that provide inputs to a TRACON, the principal types of inputs provided by each of these facilities, TRACON functions, the facilities that are provided with outputs from a TRACON, and the principal types of outputs provided to those facilities by the TRACON.

- o TRACON Facilities System Connectivity (3.2). This section contains three connectivity diagrams -- one for each of the three system phases (see above). The changes in connectivity between phases are briefly described.

- o TRACON Facilities Tentative Implementation Schedule (3.3). This section contains a figure that shows the tentative implementation schedule for the principal improvements affecting the TRACON Facilities.

- o TRACON Facilities Interface Planning Summary (3.4).

This section summarizes the major assumptions that were made in regard to the implementation and interfacing of the various improvements.

3.1 TRACON Facilities Improvements Summary

Tables 3-3 and 3-4 summarize the TRACON Facilities Improvements that are planned for the Near Term and Far Term. Other improvements that are less likely to be implemented according to current plans are listed as Potential and Longer Range Improvements in the same table. Table 3-3 is concerned with ARTS III and ARTS IIIA Facilities. Table 3-4 is concerned with ARTS II, ARTS IIA, and TPX-42 Facilities.

Figures 3-1, 3-2, and 3-3 show respectively, the Current, Near Term, and Far Term information flow between an ARTS III or ARTS IIIA TRACON and other elements of the ATC system. In each figure, the TRACON is shown as a large box in the middle. The inputs to the TRACON are shown to the left of the box; the outputs from the TRACON are shown to the right. Within the box itself, functions/features are listed. For the Near Term and Far Term figures, these are the new functions/features that are expected to be available at the end of the period for which the figure was prepared. The Current figure shows the functions/features as they existed in December 1980. In some cases, the inputs and outputs that are listed are general categories of inputs and outputs for a TRACON rather than all of the input and output message types within the categories.

The principal changes in information flow and functions from the Current system to the Near Term system are underlined in Figure 3-2. Similarly, underlining is used in Figure 3-3 to indicate

TABLE 3-3
ARTS III AND ARTS IIIA
FACILITIES IMPROVEMENTS SUMMARY

Functions/Features	Current System (1980)	Near Term Improvements (1981-84)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
1. Terminal Data Processing Equipment	• ARTS III	• ARTS III Replaced by ARTS IIIA*	• TIDS	• ARTS Computer Replacement • Applications Processor for DABS Data Link • Terminal Consolidation
2. Terminal Input/Output Equipment	• FDEP • Time-shared Situation Displays	• FDEPs Replaced by FDIOs* • SRAP* at ARTS IIIA* Sites	• Video Reconstitutor (Temporary) • Time-shared Situation Display Replaced by FDAD • TIDS Displays • SRAP Removed, CMC Added (RDAS or MTD at Surveillance Sites)	• Terminal Surveillance Channel Backup System
3. Processing and Display of Aircraft and Weather Data	• Display of Video Search Radar Returns and Processed Beacon Target Replies • Correlating User of Beacon Data • Automatic Tracking of Beacon Replies	• Addition of Search Radar Tracking through Returns Digitized by SRAP* • Correlating User of Beacon and Search Data	• Video Reconstitution of Digital Surveillance Data Received from DABS Sites (Temporary Method) • Non-Correlating User of Beacon and Search Data • Processing of Data from DABS/ATARS Sites • Display of Additional Digitized Weather Data (Turbulence and Wind Shear) • Digital Display of Search Radar and Beacon Target Reports	• Display of Three-dimensional Weather Data • TRACON Weather Processing Function
4. Aircraft Separation Services	• Conflict Alert	• BCAS (Active) • RBX	• ATARS	• BCAS (Full)
5. Communication with Aircraft	• Voice Radio (VHF & UHF)	NC	• DABS Data Link Available • CMA	
6. Detection of Unsafe/Unacceptable Use of Airspace	• MSAW	NC	• ATARS Terrain, Obstacle, and Airspace Avoidance	
7. Traffic Flow Management	• Manual	NC	• Terminal Sequencing and Spacing	

*	Approved by the FAA for Implementation	MSAW	Minimum Safe Altitude Warning
ATARS	Automatic Traffic Advisory and Resolution Service	MTD	Moving Target Detector
BCAS	Beacon Collision Avoidance System	NC	No Change Included in Current Plans
CMA	Control Message Automation	RBX	Radar Beacon Transponder
CMC	Communications Multiplexor Controller	SRAP	Sensor Receiver and Processor
DABS	Discrete Address Beacon System	TIDS	Terminal Information Display System
FDAD	Full Digital ARTS Display	UHF	Ultra High Frequency
FDEP	Flight Data Entry and Printout (Equipment)	VHF	Very High Frequency
FDIO	Flight Data Input Output Equipment		

TABLE 3-4
ARTS II, ARTS IIA, AND TPX-42
FACILITIES IMPROVEMENTS SUMMARY

Functions/Features	Current System (1980)	Near Term Improvements (1981-84)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
1. Terminal Data Processing Equipment	• ARTS II • TPX-42	• TPX-42 Replaced by ARTS-II-like Equipment	• ARTS IIA	• ARTS Computer Replacement • Applications Processor for DABS Data Link • Terminal Consolidation
2. Terminal Input/Output Equipment	• FDEP • Time-shared Situation Displays	• FDEPs Replaced by FDIOs*	• Video Reconstitutor (Temporary) • Time-shared Situation Displays Replaced by FDADs	• Terminal Surveillance Channel Backup
3. Processing and Display of Aircraft and Weather Data	• Display of Processed Beacon Target Replies (ARTS II and TPX-42) • Display of Video Search Radar Returns (ARTS II)	NC	• Digital Display of Search Radar and Beacon Target Reports • Display of Additional Digitized Weather Data (Turbulence and Wind Shear) • Processing of Data from DABS/ATARS Sites • Video Reconstitution of Digital Surveillance Data Received from DABS Sites (Temporary Method) • Automatic Tracking of Beacon Replies	• TRACON Weather Processing Function • Display of Three-dimensional Weather Data
4. Aircraft Separation Services	• Manual	• BCAS (Active) • RBX	• ATARS • Conflict Alert	• BCAS (Full)
5. Communication with Aircraft	• Voice Radio (VHF and UHF)	NC	• DABS Data Link Available • CMA	
6. Detection of Unsafe/Unacceptable Use of Airspace	• TPX-42 Low Altitude Alerting System	NC	• MSAW • ATARS Terrain, Obstacle, and Airspace Avoidance	
7. Traffic Flow Management	• Manual	NC	NC	

*	Approved by the FAA for Implementation	MSAW	Minimum Safe Altitude Warning
ATARS	Automatic Traffic Advisory and Resolution Service	MTD	Moving Target Detector
BCAS	Beacon Collision Avoidance System	NC	No Change Included in Current Plans
CMA	Control Message Automation	RBX	Radar Beacon Transponder
CMC	Communications Multiplexor Controller	SRAP	Sensor Receiver and Processor
DABS	Discrete Address Beacon System	TIDS	Terminal Information Display System
FDAD	Full Digital ARTS Display	UHF	Ultra High Frequency
FDEP	Flight Data Entry and Printout (Equipment)	VHF	Very High Frequency
FDIO	Flight Data Input Output Equipment		

INPUTS

From Terminal Surveillance Site
- -- Search Radar
  - Broadband (Video) Aircraft and Weather Returns (two-dimensional) (range, azimuth)
- -- ATCRBS
  - Broadband Aircraft Replies (range, azimuth, identification, altitude)

From the Host ARTCC
- Flight Plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Strip Data (FDEP)
- General Information Messages
- Tower En Route Messages
- CWSU Weather Data
- PIREPs
- Coordination

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPs
- Requests for Information
- Progress Reports

From Tower Cab (High IFR Activity Airport)
- Coordination
- Handoffs
- Weather and Airport Data
- Wind Shear Data
- Airport Weather Sensor Data

From Tower Cab (Satellite Airport)
- Handoffs
- Weather and Airport Data

From ATCCC
- Assistance in Handling Calamities or Impending Calamities
- Requests for Situation Reports
- Arrival and Departure Delay Predictions

From Other TRACON Facility
- Coordination
- Tower En Route Handoffs

Current TRACON Facility (ARTS III Unless Otherwise Designated)

FUNCTIONS

1. Terminal Data Processing Equipment
   ARTS III, ARTS II, and TPX-42 systems
2. Terminal Input/Output Equipment
   FDEP; Time-shared situation displays
3. Processing and Display of Aircraft and Weather Data
   Display of video search radar returns and processed beacon target replies
   Automatic Tracking of Beacon Replies
   Correlating User of Beacon Data
4. Aircraft Separation Services
   Terminal Conflict Alert
5. Communication with Aircraft
   Voice Radio (VHF & UHF)
6. Detection of Unsafe/Unacceptable Use of Airspace
   MSAW; Low Altitude Alerting System (TPX-42)
7. Traffic Flow Management
   Manual management of flow

OUTPUTS

To the Host ARTCC
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDEP)
- General Information Messages (FDEP)
- Tower En Route Messages
- PIREPs
- Coordination

To Aircraft (Air Crew,
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To Tower Cab (High IFR Activity Airport)
- Coordination
- Arrival Sequence Data and Arrival Flight Strip Data
- Handoffs
- Weather Data
- ASR/ATCRI BRITE Surveillance Data

To Tower Cab (Satellite Airport)
- Arrival Sequence Data and Arrival Flight Progress Strip Data
- Handoffs
- Weather Data
- ASR/ATCRI BRITE Surveillance Data

To ATCCC
- Situation Reports (personnel staffing, local weather, equipment status, radio frequencies, problem areas)
- Requests for Assistance in Handling Calamities or Impending Calamities
- Diversion Messages

To Other TRACON Facility
- Coordination
- Tower En Route Handoffs

FIGURE 3-1
CURRENT TRACON FACILITIES (ARTS III)
INFORMATION FLOW DIAGRAM

INPUTS

From Terminal Surveillance Site
- -- Search Radar
  - Broadband Aircraft and Weather Returns (two-dimensional) (range, azimuth)
- -- ATCRBS
  - Broadband Aircraft Replies (range, azimuth, identification, altitude)

From RBX (Radar Beacon Transponder)
- BCAS Controller Advisory Messages

From the Host ARTCC
- Flight plans, FP Changes
- Handoff and Track Messages
- Flight Plan and Flight Progress Strip Data (FDIO)
- General Information Messages (to computer & FDIO)
- Tower En Route Messages
- PIREPs
- CWSU Weather Data

From Aircraft (Air Crew, Data Link Available)
- Flight Plans, Request for FP Changes
- Requests for Clearance
- PIREPs
- Requests for Information
- Progress Reports

From Tower Cab (High IFR Activity Airport)
- Coordination
- Handoffs
- Weather and Airport Data
- Wind Shear Data
- Airport Weather Sensor Data (TDDS)

From Tower Cab (Satellite Airport)
- Handoffs
- Weather and Airport Data

From ATCCC
- Assistance in Handling Calamities or Impending Calamities
- Requests for Situation Reports
- Arrival and Departure Delay Predictions

From Other TRACON Facility
- Coordination
- Tower En Route Handoffs

Near Term TRACON Facility (ARTS IIIA Unless Otherwise Designated)

FUNCTIONS

1. Terminal Data Processing Equipment
   ARTS IIIA
   Video Reconstitutors
   TPX-42s replaced by ARTS-II-Like Equipment

2. Terminal Input/Output Equipment
   FDEPs replaced by FDIOs
   SHAPs at ARTS IIIA Sites

3. Processing and Display of Aircraft and Weather Data
   Video reconstitution of digital surveillance data received from DABS sites
   Correlating User of Beacon and Search Data
   Search radar tracking

4. Aircraft Separation Services
   BCAS (Active)
   RBX

5. Communication with Aircraft
   Voice Radio (VHF & UHF) (no change)

6. Detection of Unsafe/Unacceptable Use of Airspace
   MSAW; Low Altitude Alerting System (TPX-42) (no change)

7. Traffic Flow Management
   Manual management of flow (no change)

Underlined words = changes from Current version to Near Term version of system

OUTPUTS

To RBX
- BCAS Desensitization Control Messages

To the Host ARTCC
- Handoff and Position Messages
- Departure Messages
- Terminate Beacon Code Messages
- Flight Plan Data (FDIO)
- General Information Messages (FDIO)
- Tower En Route Messages
- PIREPs

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPs

To Tower Cab (High IFR Activity Airport)
- Arrival Sequence Data and Arrival Flight Progress Strips
- Handoffs
- Weather Data
- ASR/ATCBI Digital Surveillance Data
- Coordination

To Tower Cab (Satellite Airport)
- Arrival Sequence Data and Arrival Flight Progress Strips
- Handoffs
- Weather Data
- ASR/ATCBI Digital Surveillance Data

To ATCCC
- Situation Reports (personnel staffing, local weather, status, radio frequencies, problem areas)
- Requests for Assistance in Handling Calamities or Impending Calamities
- Diversion Messages
- Arrival Messages

To Other TRACON Facility
- Coordination
- Tower En Route Handoffs

FIGURE 3-2
NEAR TERM TRACON FACILITIES (ARTS IIIA)
INFORMATION FLOW DIAGRAM

INPUTS

From Terminal Surveillance Site
- -- Search Radar
  - • Digitized Aircraft Target Reports (range, azimuth)
  - • Digitized Two-dimensional Weather Data
- -- DABS
  - • Digitized DABS/ATCRBS Aircraft Target Reports (range, azimuth, identification, altitude)
- -- DABS Data Link
  - • Controller Advisory (ATARS, BCAS) Messages
  - • Track Alert Messages

From RBX (Radar Beacon Transponder)
- • BCAS Controller Advisory Messages

From NEXRAD
- • Digitized Three-dimensional Weather Data (Precipitation, Turbulence, Wind Shear)

From JAWOS
- • Weather Data

From the Host ARTCC with TIDS Data Interface
- • Flight Plans, FP Changes
- • Handoff and Track Messages
- • General Information Messages
- • Tower En Route Messages
- • Metering Data
- • CWSU Weather Data

From Aircraft (Air Crew, Data Link Available)
- • Flight Plans, Requests for FP Changes
- • Requests for Clearances
- • PIREPs
- • Requests for Information
- • Progress Reports

From Tower Cab (High IFR Activity Airport)
- • *Coordination*
- • Handoffs
- • Weather and Airport Data
- • Airport Weather Sensor Data (TIDS)

From Tower Cab (Satellite Airport)
- • Handoffs
- • Weather and Airport Data

From ATCCC
- • Assistance in Handling Calamities or Impending Calamities
- • Requests for Situation Reports
- • Arrival and Departure Delay Predictions

From Other TRACON Facility
- • Coordination
- • Tower En Route Handoffs

Far Term TRACON Facility (ARTS IIIA Unless Otherwise Designated)

FUNCTIONS

1. Terminal Data Processing Equipment
   Terminal Information Display System (TIDS)
   ARTS IIA
2. Terminal Input/Output Equipment
   Video Reconstitutor (Temporary)
   Full Digital ARTS Display (FDAD)
   TIDS displays
   SHAP removed, CNC added
3. Processing and Display of Aircraft and Weather Data
   Display of three-dimensional digitized weather data (precipitation, turbulence and wind shear)
   Digitized display of search radar and beacon target reports
   Video Reconstitution (Temporary)
   ARTS IIA Automatic Tracking of Beacon Replies
   Non-correlating User of Search and Beacon Data
4. Aircraft Separation Services
   ATARS
   ARTS IIA Conflict Alert
5. Communication with Aircraft
   DABS Data Link Available
   CNA
6. Detection of Unsafe/Unacceptable Use of Airspace
   ATARS Terrain, Obstacle, and Airspace Avoidance
   ARTS IIA MSAW
7. Traffic Flow Management
   Terminal Sequencing and Spacing (TSS)

Underlined words - changes from Near Term to Far Term version of system

OUTPUTS

To Terminal Surveillance Site
- -- DABS Data Link
  - • MSAW Advisories
  - • Altimeter Correction Messages
  - • ETIS Messages
  - • Aircraft Control State Messages

To RBX
- • *BCAS Desensitization Control Messages*

To the Host ARTCC with TIDS Data Interface
- • Handoff and Position Messages
- • Departure Messages
- • Terminate Beacon Code Messages
- • Flight Plan Data
- • General Information Messages
- • Tower En Route Messages
- • Metering Data
- • PIREPs

To Aircraft (Air Crew, Data Link Available)
- • *Clearances*
- • *FP Modifications*
- • Instructions, Advisories
- • Requests for PIREPs

To Tower Cab (High IFR Activity Airport)
- • Coordination
- • Arrival Sequence Data and Flight Data (TIDS)
- • Handoffs
- • Weather Data
- • ASR/DABS Digital Surveillance Data

To Tower Cab (Satellite Airport)
- • Arrival Sequence Data and Flight Data (TIDS)
- • Handoffs
- • *Weather Data*
- • ASR/DABS Digital Surveillance Data

To ATCCC
- • Situation Reports (personnel staffing, local weather, equipment status, radio frequencies, problem areas)
- • Requests for Assistance in Handling Calamities or Impending Calamities
- • Arrival and Diversion Messages

To Other TRACON Facility
- • *Coordination*
- • Tower En Route Handoffs

FIGURE 3-3
FAR TERM TRACON FACILITIES (ARTS IIIA)
INFORMATION FLOW DIAGRAM

the principal changes from the Near Term system to the Far Term system. The changes in functions, the inputs to the functions, and the outputs from the functions are described in the following paragraphs.

3.1.1 Terminal Data Processing Equipment

This section and the following section (3.1.2 Terminal Input/Output Equipment) are generally concerned with equipment in TRACONs/TRACABs, as opposed to software, software functions, and data processing in TRACONs/TRACABs. However, for ARTS IIA and ARTS IIIA, software functions are briefly discussed since they are the major distinguishing features among the systems.

3.1.1.1 Current System

ARTS III, ARTS II, and TPX-42 systems are the data processing capabilities that are currently available in TRACONs and TRACABs. These capabilities are limited as to speed, computing capacity, and - particularly - storage capacity. These capabilities are limited to such an extent that, in the near future, they may be unable to satisfy the TRACON/TRACAB data processing requirements. This is especially likely to occur if the requirements grow (as they are expected to) due to predicted increases in traffic load and expected functional additions. Table 3-1 summarizes the features of the various terminal automation systems.

ARTS III

ARTS III systems are currently operational at 63 TRACONs. ARTS

III is a programmable data processing system that is capable of receiving information from various sources (surveillance sites, host ARTCCs, controllers' keyboard entries, etc.) and sending information to various destinations (controllers' displays, host ARTCCs, etc.). Because it is a general-purpose data processing system, it can be programmed to provide various software functions. Among its current software capabilities are automatic tracking of beacon targets, a Conflict Alert function, and a Minimum Safe Altitude Warning (MSAW) function.

ARTS II

ARTS II -- like ARTS III -- is a programmable data processing system. Its computing and storage capacities are considerably less than those of ARTS III. The first ARTS II site became operational in December of 1978. As with ARTS III, ARTS II has the ability to communicate with its host ARTCC, with controllers through displays and keyboards, etc. Currently, ARTS II does not provide automatic tracking, Conflict Alert, or MSAW. It does display data blocks for both discrete and nondiscrete beacon replies.

TPX-42

The TPX-42 has the least capability of the currently-used terminal automation systems. It is not a programmable data processing system. However, various functions can be controlled through panel switches and dials. All of the TPX-42 facilities are now operational. The TPX-42 does not provide a tracking function, a Conflict Alert function, MSAW function, or tabular information on situation displays. It does provide labels for

discrete and nondiscrete beacon replies. However, the labels contain less information than those available in the ARTS systems. The contents of the labels are usually restricted to received Mode A beacon codes and Mode C altitude reports.

3.1.1.2 Near Term Improvements

In the Near Term, ARTS III sites will be upgraded to ARTS IIIA. Also, in the Near Term, it is expected that the TPX-42 equipment currently in operation at TRACON/TRACAB Sites will be replaced with ARTS-II-like systems.

ARTS IIIA

ARTS III and ARTS IIIA are similar systems in many respects. Many of the equipments and much of the software are common to the two. All ARTS III Systems will be replaced with ARTS IIIA Systems in the Near Term. The first ARTS IIIA Site is expected to become operational late in 1981.

ARTS IIIA is a programmable data processing system that will be capable of receiving information from various sources (surveillance sites, host ARTCCs, controllers' keyboard entries, etc.) and sending information to various destinations (controllers' displays, host ARTCCs, etc.). Because it is a general-purpose data processing system, it will be capable of being programmed to provide various software functions.

The reliability of ARTS IIIA will be increased over that of ARTS III through the use of redundant equipment and fail-soft capability. The latter will provide automatic switching of

equipment (e.g., memories or Input Output Processors) so as to remove and replace improperly functioning units. Other new features will include: search radar tracking, more storage capacity than ARTS III, multi-processing, a separate buffer memory for each display, automatic overload sensing and protection, remote tower display and data entry, and continuous data recording that can be controlled through keyboard messages.

A special expanded ARTS IIIA System is being installed in the New York TRACON. This facility is planned to use four radar sites, to have more than 30 operational displays, and to control traffic in an area that is approximately 100 nautical miles by 150 nautical miles. Displays and radars would be adapted so that each display could be served by either a primary or alternative site. The ARTS IIIA for the New York TRACON will include a Communications Multiplexer Controller. It is expected that this device will allow digital data communication (at 4800 bps) between the IFR room and BRITE (Bright Radar Indicator Tower Equipment) displays in five associated Tower Cabs. At J. F. Kennedy and Newark airports, two BRITE displays are planned for each Tower Cab. Each BRITE display will have input capability through its associated keyboard.

3.1.1.3 Far Term Improvements

In the Far Term, it is expected that ARTS IIA will be implemented and TIDS (Terminal Information Display System) will be deployed at more than 50 TRACONs.

ARTS IIA

According to current plans, ARTS IIA Systems will be implemented in the Far Term. The existing ARTS II Sites would be enhanced to reach the level of ARTS IIA. ARTS IIA Systems might also be installed at new sites that currently have no automation systems or have TPX-42 equipment.

The enhancements that would be added to ARTS II to obtain an ARTS IIA capability are:

- Automatic tracking of beacon targets
- Conflict Alert function
- Minimum Safe Altitude Warning function
- A third line in Full Data Blocks on the situation display for the display of alerts from the MSAW and/or Conflict Alert functions
- Capabilities for use of the system in training controllers

Automatic beacon tracking would be similar to that currently used in ARTS III systems. The Conflict Alert function (see 3.1.4.1) and MSAW function (see 3.1.6.1) would be similar to those in ARTS III systems. The third line in the Full Data Blocks would allow the display of Conflict Alert advisories, MSAW advisories, received beacon codes, track status, track handoff indicators, etc. Other related display improvements

would also be made. The training capabilities would include a Training Target Generator and a Training Scenario Generator. The target generator would operate on-line as part of the operational software. It would allow training to occur with simulated targets while the system operates normally with live traffic. The scenario generator would generate magnetic tapes off-line. The tapes would contain various training and test scenarios.

Terminal Information Display System (TIDS)

TIDS is a Far Term improvement that would consist of new equipment and associated software that would handle many of the ARTS IIIA interfacing, processing, and storage tasks, and would add new capabilities. It would provide the digital communication interfaces between ARTS and other facilities and equipment other than the direct ARTS interfaces with Terminal Surveillance Sites, tower cab situation displays, and RBXs (Radar Beacon Transponders). TIDS would provide individual Display and Data Entry Units for the Arrival Data and Departure Data Positions. TIDS would also provide additional capabilities for the display of data on ARTS situation displays. Radar Controllers would be able to choose alternative data to be displayed in lists and data blocks on their displays.

TIDS would improve the availability and timeliness of flight data presentations to TRACON (and Tower Cab) controllers, reduce the controller coordination workload, and support VFR flight services. TIDS would accept, process, distribute, and display flight and other non-radar data for an entire terminal area, including the TRACON and its associated Tower Cab(s). TIDS

would provide the means by which digital flight and control data would be exchanged between devices within a Tower Cab, between Tower Cabs, between a Tower Cab and its associated TRACON, and between a TRACON and its host ARTCC. TIDS would provide controllers with NOTAMs (Notice to Airmen), tabular weather data (including the especially tailored weather briefings prepared by the CWSU at the host ARTCC), and other operational information. TIDS would also provide the message entry and flight strip handling capabilities provided in the Current System by FDEP and in the Near Term system by FDIO (Flight Data Input Output) (see 3.1.2.2).

Currently, numerous status displays are associated with airport communications, navigation, and surveillance facilities. In the Far Term, the status data that is concerned with ATC operations rather than maintenance would be sent to TIDS. There, it and weather sensor information (wind, temperature, barometric pressure, etc.), ceiling data, Runway Visual Range Data, etc., would be integrated and consolidated into TIDS. The resultant information would be available on special displays associated with TIDS.

3.1.1.4 Potential and Longer Range Improvements

Computer Replacement

The replacement/augmentation of the terminal area computers (ARTS IIIA, ARTS III, ARTS IIA, ARTS II) is a longer range improvement. As air traffic volume increases and software capabilities are added to TRACONs/TRACABs, the possibility of exceeding current hardware capabilities increases. Although the

computing and storage capacity of ARTS IIIA has been increased over that of ARTS III, it appears that (at least for some sites) it will be very difficult for ARTS IIIA to support all of the functional improvements that are envisioned for TRACONs - particularly if the predicted increases in traffic load occur. ARTS IIIA is especially limited as to storage capacity. Additional incentives for change arise as a result of the equipment growing older and maintenance costs rising. In order to satisfy future computing and storage capacity requirements, the replacement of terminal automation systems is being considered as a part of the FAA's ATC Computer Replacement Program.

Terminal Consolidation

Terminal Consolidation is being considered as a potential longer range improvement. According to the current concept, terminal and en route ATC functions would be integrated in an ARTCC. Terminal equipment and personnel would be placed physically at the ARTCC. New procedures and methods for handling aircraft would be developed by combining the current en route and terminal procedures and methods. Digitized surveillance data from terminal surveillance sites would be sent to the ARTCC. According to this concept, there would be:

- A single data base containing all current terminal and en route data

- New sectors tailored to specific conditions (e.g., transitioning, cruising, traffic flow, airports to be served)

- Mosaicked surveillance data from the terminal and en route surveillance sites

- Reduction of aircraft vectoring near terminals

- Simplification of stratification in en route airspace

- Integration of management, controller, and support personnel from terminals and ARTCCs

Terminal Consolidation is of particular interest at this time because of the possibility of incorporating such new features in conjunction with the future replacement of en route ATC computers.

Applications Processor for DABS Data Link

A data processing capability is needed to send ETIS (Enhanced Terminal Information Services) messages and other DABS Data Link messages from TRACONs to aircraft. Such a capability could be contained within ARTS, TIDS, or NADIN, or could be stand-alone equipment. At this point, all of these alternatives are under consideration.

3.1.2 Terminal Input/Output Equipment

This section and the previous section (3.1.1 Terminal Data Processing Equipment) are generally concerned with equipment in TRACONs/TRACABs as opposed to software, software functions, and data processing in TRACONs/TRACABs. The equipment described in

this section is primarily concerned with improvements in the input and output of information to equipment and personnel at TRACONs/TRACABs. Most of the devices that allow controllers to enter or see data are included. Equipments concerned with the input of surveillance data are also included.

3.1.2.1 Current System

Currently, the principal Input/Output Equipment used in TRACONs are FDEPs (Flight Data Entry and Printout equipment), ARTS Keyboard Input Modules, and ARTS time-shared situation displays.

FDEP

Most flight data from the host ARTCC is printed as Flight Progress Strips on FDEPs. These strips must be marked and distributed by TRACON and Tower Cab controllers. Coordination among various control positions requires a large amount of voice communication.

Time-Shared Situation Displays

Both digital and analog data are displayed on ARTS situation displays. Data blocks and lists are displayed through digital techniques; aircraft and weather target data are displayed through analog (broadband) techniques. The present displays and displayed data have a number of undesirable characteristics. The brightness of the displayed targets on the situation displays gradually decreases after the rotating radar/beacon beam "paints" the targets. The displayed targets tend to be smeared lines rather than discrete targets. Digital writing

time is severely limited since it can only occur during "radar dead time." Display selectivity is very limited.

3.1.2.2 Near Term Improvements

In the Near Term, ARTS III sites will be upgraded to ARTS IIIA, and FDEPs will be replaced with FDIOs (Flight Data Input Output equipment). Surveillance input capabilities will be improved through the deployment of SRAP (Sensor Receiver And Processor).

Flight Data Input Output Equipment (FDIO)

In the Near Term, the input/output situation will be improved through the replacement of FDEP equipment. The new equipment, FDIO (Flight Data Input Output), will be faster, more flexible, more reliable, and easier to maintain.

At the TRACONs/Towers, the FDEPs will be replaced with FDIO Cathode Ray Tube (CRT) displays, keyboards, and printers. The FDIO control equipment at TRACONs/Towers will communicate with the CCC at a rate of 2400 bits per second (bps). The minimum data rate capabilities of the input/output equipment at the TRACONs/Towers will be: CRT - 2400 bps, Keyboard - 1200 bps, and Printer - 30 characters per second.

Surveillance Data Input Equipment

In the Near Term, SRAP (Sensor Receiver and Processor) will be installed as part of each ARTS IIIA. It will be used to digitize the search radar information needed for radar tracking

and to digitize the beacon information that is currently digitized by the Beacon Data Acquisition Subsystem of ARTS III.

3.1.2.3 Far Term Improvements

In the Far Term, TIDS will provide new tabular displays and alternative data block data for the ARTS situation displays. Further information on TIDS can be found in 3.1.1.3 and 3.1.3.3. Video reconstituters would be deployed to function with the current time-shared situation displays until FDADs (Full Digital ARTS Display) would be available later in the Far Term.

Display Equipment

In the Far Term, when either the Moving Target Detector (ASR-9) or DABS is implemented at a surveillance site, digital rather than analog (broadband) data would be sent from the surveillance site to the indicator (ARTS) site. However, all-digital situation displays are not expected to be available at all sites at that time. A temporary method of displaying this data would be available through video reconstitution of the digital data. This would require the installation of reconstitution equipment at the ARTS sites. Prototype reconstitutors have been built, and their feasibility has been demonstrated. It is assumed that the reconstituted display will be found acceptable for air traffic control even though it does not provide the variations in target size, shape, and brightness that are available with normal broadband data.

At some ARTS sites, FDADs (Full Digital ARTS Displays) are

expected to replace the current broadband/digital displays. In order to furnish a smooth transition between the current time-sharing mode and an all-digital mode, FDAD is being designed to function in either mode. In addition to this flexibility, FDAD would provide improved display characteristics. The new displays would provide more distinct, non-fading, less variable display of search radar targets and beacon replies; greater selectivity and filtering of information to be displayed; and additional digital writing time. FDAD as currently envisioned could also provide color (multi-chromatic) displays, internal memory, buffer refresh capability, internal storage of geographic maps, programmable functions, and interfacing capabilities for all of the varieties of ARTS systems.

Surveillance Data Input

It is expected that broadband surveillance data capabilities would be removed in order to decrease equipment maintenance costs. However, no firm decision has been made. It is possible that the broadband capability would be retained as backup for the digital surveillance data.

3.1.2.4 Potential and Longer Range Improvements

Terminal Surveillance Channel Backup

A Terminal Surveillance Channel Backup capability is a potential improvement that is under consideration. The backup function would have to provide target data and some alphanumeric data if the primary channel through the Input Output Processor and

Multiplexed Display Buffer Memory is not available due to failure or maintenance requirements. It may be necessary to provide such a capability before replacement Terminal ATC computers would be available that would incorporate such a capability. It would be similar to DARC (see 2.1.1.1).

3.1.3 Processing and Display of Aircraft and Weather Data

3.1.3.1 Current System

Currently, three principal types of information are displayed on ARTS III and ARTS II situation (plan view) displays:

- o surveillance information (aircraft and weather returns from search radar and aircraft replies from beacon transponders)

- o geographic map data (runways, boundaries, airways, handoff points, etc.)

- o alphanumeric characters and symbols (data blocks, including position symbols, leaders, and tabular data; lists; preview information; and system information).

These are generated separately, and their signals combined immediately before the displays.

The surveillance information is received in broadband form from terminal surveillance sites. It (Moving Target Indicator search radar video, normal search radar video, and beacon video) is

displayed using a radial scan mode (Plan Position Indicator mode) on ARTS displays. In this mode, information is written on the display in a sequence corresponding to the sweeps of radar/beacon pulses that are sent out from the rotating radar antennas.

Geographic map data is generated at the TRACON by scanning a graphic image of the geographic area around the radar site. The image is scanned electronically in synchronism with the surveillance radial scan.

The locations and identification of alphanumeric characters and symbols are stored and processed digitally. They are written in a random sequence that is independent of the radial scan. The characters and symbols are written in the radar "dead time" between sweeps. A sweep ends when the radar pulses have reached a distance of 55 (or 42 for some displays) nautical miles from the radar site. The characters and symbols are written in the time between this occurrence and the start of the next sweep (at the next azimuth position).

The broadband beacon replies, in addition to being displayed, are converted to digital data in the Data Acquisition Subsystem of ARTS III. This digitized information is sent to the ARTS III Data Processing Subsystem (DPS) and is used for automatic tracking of beacon-equipped aircraft. The DPS then provides predicted track positions and data block information for display on the situation displays.

3.1.3.2 Near Term Improvements

ARTS IIIA

One of the key functional improvements provided by ARTS IIIA is the expansion of processing to include search radar targets in addition to beacon targets. The system will track such targets and will display data blocks that identify the tracked aircraft.

FDIO

With the implementation of FDIO (see 3.1.2.2), the FDEP functions will be assumed by FDIO. The new equipment will allow the entry of General Information messages in addition to the previous message capabilities provided by FDEP.

Weather

In the Near Term, CWSU personnel at the host ARTCC would prepare and update tailored weather descriptions for each TRACON. These would be available to the TRACON controllers via voice phone.

3.1.3.3 Far Term Improvements

TIDS

With the implementation of TIDS at some TRACONs, the FDIO's function as an input or output device would be assumed by TIDS. All of the messages that could only be sent from a TRACON to its host ARTCC via FDEPs in the Current System, and FDIOs in the Near Term system, would be capable of being entered through TIDS

consoles. Furthermore, the ARTCC would no longer be required to route flight progress strip information to FDEPs/FDIOs in TRACONs equipped with TIDS. Instead, TIDS would prepare and display similar information from the extensive flight plan data that it received from the host ARTCC, FSSs, and local entry devices. With TIDS, full flight data could be displayed for IFR and VFR flights. Most voice coordination work would be replaced by simple computer entries made by controllers.

Inputs to TIDS would be:

- o IFR flight plans and flight plan changes. Obtained from the host ARTCC and keyboard entries by terminal controllers.

- o VFR flight plans and flight plan changes. Obtained from adjacent TRACONs and keyboard entries made by terminal controllers.

- o Handoff, Track, and General Information messages. Obtained from the host ARTCC, this TRACON, and adjacent TRACONs.

- o Weather Briefings. Obtained from the CWSU in the host ARTCC.

- o Miscellaneous data to be stored, processed, or forwarded. Obtained from the ARTS III system.

Outputs from TIDS would be:

- o Displays of alternative list and data block data. Provided to TRACON Radar Controllers through ARTS III.

- o Handoff, Track, General Information, Departure Messages. Sent to the host ARTCC, this TRACON, and adjacent TRACONs.

- o Terminate Beacon Code messages. Sent to host ARTCC.

- o Miscellaneous data to be displayed or transmitted at the request of the ARTS III system. Sent to terminal controllers or host ARTCC.

- o Requests for Weather Briefings. Sent to CWSU at the host ARTCC.

Surveillance Data Processing

The surveillance data as received from DABS sites would be tagged with specific track identifications as a result of the DABS site's performance of correlation of surveillance data with existing or automatically initiated tracks. This would significantly decrease the ARTS processing load.

With the implementation of DABS at Terminal Surveillance Facilities, it is expected that broadband surveillance data would no longer be available to ARTS sites in the Far Term. However, it is possible that the broadband capability would be retained as backup to the digital surveillance data.

Weather

In the Far Term, digitized graphical weather data from radar sites would be provided to TRACONs. It would consist of various combinations of three-dimensional weather data, turbulent weather data, and wind shear data. The full use of the three-dimensional weather data for display purposes is not planned for the Far Term. No decisions have been made as to how this graphical weather data would be presented on displays. Inputs would be digitized weather data from ASR or NEXRAD weather radar sites. Outputs might include weather contours displayed on Radar Controllers' situation displays.

3.1.3.4 Potential and Longer Range Improvements

Weather

The Aviation Weather System (see 2.1.2.4) is a potential integrated weather capability that would improve the availability of weather data to TRACONs. The CWSU at the host ARTCC would receive PIREPs from ARTCC controllers or from pilots and would receive graphic and alphanumeric weather information from the Center Weather Processing complex (CWPC). CWSU personnel would analyze the information and would prepare weather advisory information in alphanumeric and graphic (situation display) forms. This digital data would be sent to the CWPC. The CWPC would send to the TRACON (via TIDS) the CWSU data and other weather data that the CWPC had received. TIDS would perform the weather processing functions that would be required to display the tabular data on TIDS displays and to display the graphic data on ARTS situation displays.

The full use of three-dimensional weather data and multiple weather contours (levels of weather intensity) on situation displays is a potential, longer range improvement. Weather contours could be displayed using various levels of brightness or various colors to indicate the relative severity of turbulence or precipitation.

3.1.4 Aircraft Separation Services

Although the principal ATARS and BCAS equipment are not contained within TRACON rooms, they are described here, since their first use would be in terminal airspace, and they would be part of the automated Aircraft Separation Services of which Terminal Conflict Alert is a part. The source for much of the following descriptive information is "Aircraft Collision Avoidance: Concepts and Systems", Reference 3-24.

Automated Aircraft Separation Services provide backup capabilities for the air traffic control separation services supplied by controllers at terminals (or ARTCCs). The backup capabilities substantially reduce the likelihood of mid-air collisions. They can be classified as to the direct recipients - controllers or pilots - of the automated warnings and recommendations for maneuvers to avoid collisions. Thus, the functions are:

- o Controller-oriented Functions
  - Conflict Alert
  - Conflict Resolution Advisory (En Route, only)

o Pilot-oriented Functions

- Automatic Traffic Advisory and Resolution Service (ATARS)

- Beacon Collision Avoidance System (BCAS)

The Conflict Alert and Conflict Resolution Advisory functions are automated, ground-based capabilities designed to aid air traffic controllers in providing safe separation to controlled aircraft. Conflict Alert provides controllers with warnings of aircraft that are too close to each other or that, according to predictions, will be too close to each other in the near future. It is currently operational at all ARTS III sites and ARTCCs. Installation at all automated terminal sites is planned for the future. At ARTCCs, the Conflict Resolution Advisory function would be installed. It would extend the Conflict Alert capabilities by providing controllers with recommended aircraft maneuvers to avoid collisions.

ATARS and BCAS are automated capabilities designed to aid pilots in maintaining safe separation of aircraft. They would provide backup to controllers and to Conflict Alert. ATARS is a ground-based system designed to provide effective service in the high traffic density airspace served by the Discrete Address Beacon System (DABS) (see Chapter 7). BCAS is an airborne collision avoidance system designed to serve airspace outside ATARS coverage. It would function through replies that it would receive from DABS and ATCRBS (Air Traffic Control Radar Beacon System) transponders on other aircraft. It would use these inputs to calculate range, relative altitude, and closing rate

information in relation to nearby aircraft. When the projected time to closest approach is about 30 seconds, BCAS would indicate recommended avoidance maneuvers on a display in the cockpit of the BCAS-equipped aircraft.

ATARS and BCAS would be interfaced to ensure the compatible functioning of the two systems near the boundaries of ATARS coverage. Resolution Advisory Registers in the ATARS and BCAS avionics are designed to coordinate ATARS and BCAS conflict information and resolutions. ATARS and BCAS are expected to be operational in en route and terminal airspace.

3.1.4.1 Current System

The Terminal Conflict Alert Function has been implemented at all ARTS III sites. It provides automatic detection of potential conflicts between tracked aircraft in terminal areas.

The determination by the Terminal Conflict Alert Function of when a conflict alert should be declared is through the use of three detection modules. One predicts conflicts assuming that the tracks will maintain constant speed and straight line paths. Another predicts conflicts based on continued maneuvering of an aircraft pair in the direction in which either or both aircraft are already maneuvering. The third module does not use prediction; it bases its warnings on the proximity of aircraft to each other. Each of these detection modules is highly parameterized. Different parameter sets are tailored for each of three types of airport areas that have been defined. The three types are: areas around major or satellite airports, extensions of the areas around major or satellite airports, and

any remaining area not included in the first two types.

Inputs to the Terminal Conflict Alert Function are:

- o positional information. Obtained from the ARTS III Automatic Tracking program.
- o airport area geographic information. Obtained from the ARTS III Adaptation data base.

Outputs from the Terminal Conflict Alert Function are:

- o displayed warnings. Provided on the situation (plan view) displays of the appropriate terminal controllers.
- o aural warnings. Provided at the sector control positions of the appropriate controllers.

3.1.4.2 Near Term Improvements

In the Near Term, the Terminal Conflict Alert Function will be included within the ARTS IIIA Systems that will replace the ARTS III Systems. Also in the Near Term, BCAS is expected to be implemented.

BCAS

BCAS has been designed primarily to aid pilots in maintaining safe separation of aircraft. It would also serve as a backup to controllers and to the Conflict Alert capability provided by TRACONs and ARTCCs. It is anticipated that BCAS avionics would

be installed in most air carrier and high performance general aviation aircraft. BCAS concepts are still evolving, so the descriptive information contained in these paragraphs should be considered to be tentative.

Active BCAS is being developed for implementation in the Near Term. Active BCAS would obtain its data by interrogating the transponders that are within range (approximately 20 miles). Such interrogations might interfere with the interrogations generated by ground-based ATC surveillance facilities. An aircraft with Active BCAS would therefore have to have this equipment desensitized when it is near major terminals or is in other high activity areas.

Radar Beacon Transponder (RBX)

In the Near Term, it is expected that RBXs will be deployed at some airports to aid the BCAS function. The RBX would exchange digital messages with BCAS equipment in aircraft and with the ARTS equipment in the associated TRACON. RBX would improve the BCAS performance by adjusting the BCAS sensitivity (volume of protective airspace around the aircraft) of its conflict detection logic to the particular airspace environment. Adjustment is necessary near busy airports because, with the traffic flow in that environment, BCAS (using its normal sensitivity) would produce an unacceptably large number of unnecessary alerts. RBX would have the capability of changing this sensitivity to a more appropriate level for the environment. The RBX would select the proper sensitivity level by comparing an aircraft's range and altitude (relative to the RBX) to stored pairings of sensitivity levels to

ranges/altitudes. The RBX would then send the aircraft a sensitivity level control message that would adjust the aircraft's BCAS sensitivity accordingly. In general, the closer the BCAS-equipped aircraft would be to the runway, the smaller would be the protective volume of airspace around the aircraft. Occasionally, the RBX pairings of sensitivity levels to ranges/altitudes might need to be adjusted (e.g., because of changes in the amount of traffic activity or in the runway configuration). This could be accomplished dynamically through the sending of BCAS Desensitization Control messages to the RBX from the TRACON.

In addition to the above capabilities, RBX would be able to send BCAS Controller Advisory Messages to the TRACON. RBX would receive such a notification message from BCAS each time that an advisory is issued to a pilot by BCAS.

3.1.4.3 Far Term Improvements

In the Far Term, ATARS is expected to be implemented. Upon installation of DABS equipment at an airport, the RBX functions generally would be performed by DABS.

ATARS

ATARS is an Aircraft Separation Service provided by a totally automated ground computer system. It is an outgrowth of the Intermittent Positive Control (IPC) concept that was described and recommended for development by the Air Traffic Control Advisory Committee in 1969.

ATARS would track target data obtained from DABS and check all pairs of aircraft to see if they are too close to one another or are in danger of colliding. If there is danger of collision, ATARS would prepare threat and resolution advisory messages and have them uplinked to ATARS-equipped aircraft through DABS Data Link. (This information would also be sent to TRACONs (and ARTCCs) for display at appropriate control positions.) The information would be displayed to the pilot on an ATARS display in the cockpit. It would warn him of proximate aircraft and/or threat aircraft and, when necessary, instruct him to take specific actions in order to avoid collision.

DABS/ATARS would <u>not</u> be able to send threat and resolution advisory messages to ATCRBS-equipped aircraft. According to a current development concept, DABS/ATARS would be able to send such information (for controlled, ATCRBS-equipped aircraft) to the en route and terminal computers. Those computers would then be able to provide the appropriate controllers with warning messages and recommended aircraft maneuvers. Where possible, the information could then be relayed to aircraft by controllers via voice radio.

To receive ATARS service directly, an aircraft would have to carry:

- A DABS Transponder
- An Encoding Altimeter
- An ATARS Display

The DABS transponder, in addition to its surveillance function, would receive digital advisory messages from the ground and deliver them to the ATARS display for presentation to the pilot.

The ground portion of the DABS/ATARS system would consist of:

- The DABS Sensor. It would provide surveillance information and act as a communication link to the aircraft.

- A Computer Located at the DABS Sensor Site. It would be independent of the existing air traffic control computer system.

- Interfaces to the Air Traffic Control Facilities That Serve the Airspace Covered by the DABS Sensor.

ATARS is being developed to provide pilots of ATARS-equipped aircraft with an effective resolution service and a complementary traffic advisory service. For ATARS-equipped, uncontrolled aircraft, the traffic advisory service would enhance the pilot's see-and-avoid capability while the resolution service would provide collision avoidance services not previously afforded by the air traffic control system. In the case of controlled aircraft, ATARS would serve as a separation assurance backup to the existing air traffic control system.

ATARS services could be provided to all aircraft, controlled and uncontrolled, in both the en route and terminal environments. For those equipped for ATARS services, protection would be provided against all aircraft that are equipped with altitude

reporting (Mode C) transponders. Although resolution service could not be provided against non-Mode C aircraft, traffic advisories would be provided to ATARS-equipped aircraft regarding the presence of Mode A and primary radar targets that are proximate in the horizontal plane.

Aircraft equipped for ATARS service would receive traffic advisories regarding aircraft that have been determined to be proximate or to constitute a potential threat. In the case of a proximate aircraft, information would be displayed to alert the pilot concerning the presence of the nearby aircraft and to aid him in visual acquisition. When an aircraft poses a potential collision threat, additional information would be displayed to aid the pilot in threat assessment. The threat data would enable the pilot to evaluate the potential threat and to avoid maneuvers that would aggravate the situation. If the aircraft separation continued to narrow, both aircraft would receive resolution advisories.

Whenever a controlled aircraft is involved in a potential conflict that would result in a Conflict Alert being produced by the terminal ATC computer, ATARS would produce a Controller Alert. An ATARS Controller Alert message would be sent to the ATC facility that is responsible for the controlled aircraft. It would be sent in order to alert the controller to the potential conflict. This message would also include ATARS conflict resolution data which would provide the controller with the maneuver(s) that ATARS would issue if it were to resolve the potential conflict at the time of the Controller Alert.

In addition, an ATARS resolution notice would be sent to the

responsible ATC facility at the same time that a resolution advisory is sent to a controlled aircraft. The resolution notice would identify the aircraft involved in the conflict and the resolution advisories issued to each. Upon receipt, the ATC computer system could display this information to the responsible controller(s).

3.1.4.4 Potential and Longer Range Improvements

Full BCAS is being developed as a potential improvement. It would make use of interrogations from the ground (thus minimizing the potential interference in high density airspace) as well as interrogations from the BCAS-equipped aircraft itself. According to current concepts, Full BCAS would have three modes of operation -- with the choice of mode dependent upon the degree of surveillance coverage that is available in the area in which the aircraft is operating. The three-modes philosophy was developed to minimize the generation of interrogations by the BCAS-equipped aircraft, and therefore minimize potential interference with the normal operation of ATC surveillance.

In its active mode, Full BCAS would function in the same manner as Active BCAS. That is, it would interrogate the transponders that are within range (approximately 20 miles). In its passive mode, Full BCAS would not interrogate other aircraft. It would monitor the interrogations from ground-based ATCRBS and DABS sites and monitor the replies from the transponders on other aircraft. The hybrid mode would combine features of the active and passive modes. It would be used when the passive mode could not be operated satisfactorily by itself, but full use of the

active mode is not required. According to one design concept, this would occur when aircraft in the vicinity of the Full BCAS-equipped aircraft are being interrogated by only one beacon ground site. (Two or more beacon ground interrogators would be required for satisfactory operation of Full BCAS in the passive mode.) In the hybrid mode, Full BCAS would monitor the replies that it receives from the single ground interrogator and determine which aircraft might prove to be collision threats. Full BCAS would then interrogate these threat aircraft to obtain more information.

Full BCAS would automatically adjust its mode (active, passive, or hybrid) of operation to its environment. It would switch modes according to a priority scheme in which passive is preferred over hybrid, and hybrid is preferred over active. In any of its modes, Full BCAS would be able to calculate range, relative altitude, and closing rate from information from other beacon-equipped aircraft. In its passive mode, it would be able to obtain bearing and bearing rate information. In any of its modes, Full BCAS would be able to detect potential conflicts and prepare avoidance maneuvers when the projected time to collision is about 30 seconds. These maneuvers would be shown to the pilot on a BCAS display in the cockpit.

3.1.5 Communication with Aircraft

3.1.5.1 Current System

Currently two-way voice radio is the means by which controllers communicate with aircraft air crews.

3.1.5.2 Near Term Improvements

No improvements are planned for the Near Term.

3.1.5.3 Far Term Improvements

DABS Data Link and CMA (Control Message Automation) are improvements that are expected to be implemented in the Far Term. They are being planned and designed as an aid and supplement to the voice radio capabilities. They would be available to provide rapid non-voice communication between the ARTCC and aircraft. Many routine and high-priority messages could be transmitted via Data Link.

In the Far Term, it is expected that Altimeter Correction Messages and ETIS (Enhanced Terminal Information Services) messages will be sent to aircraft via DABS Data Link. An Altimeter Correction Message would provide the barometric pressure correction (in hundreds of feet) for the specific geographic area in which the aircraft is flying. An ETIS Message would contain real-time information in regard to an airport. The information would include weather data, status of navigation aids, and runway status. Controller Advisory (BCAS) messages would be sent to TRACONs from aircraft via DABS Data Link. CMA would provide the functional link between the TRACON and DABS Data Link. CMA would handle functions such as formatting, bookkeeping, and the establishment and use of priorities for data link ATC messages. CMA would handle messages that may be generated through automated functions such as MSAW. Work is underway in these areas, but the overall use of DABS Data Link for communication between TRACONs and aircraft

has not been determined.

3.1.5.4 Potential and Longer Range Improvements

It is expected that DABS Data Link will be used to uplink and downlink additional messages between a TRACON and aircraft. Many different types of messages are currently being considered as candidates for this service, but specific message types have not as yet been selected for implementation.

3.1.6 Detection of Unsafe/Unacceptable Use of Airspace

3.1.6.1 Current System

Currently, terminal MSAW (Minimum Safe Altitude Warning System) is operational at ARTS III sites. A similar capability, Low Altitude Alerting System, is operational at TPX-42 sites.

MSAW

MSAW uses computer software to automatically compare reported aircraft altitudes to minimum safe altitudes in order to detect unsafe or unacceptable use of airspace. The program detects instances in which an aircraft is now, or in the near future will be, below the minimum safe altitude. The alert is generated on the basis of ARTS III track and altitude data. MSAW warns a controller of such a situation through information displayed on the controller's situation display. The controller then advises the aircraft air crews of the situation through voice radio.

An aircraft is eligible for MSAW services if it is controlled and is Mode C equipped. MSAW monitoring is provided through two monitoring elements: Approach Path and General Terrain. Approach Path Monitoring is accomplished by checking the tracks of all MSAW-eligible aircraft for their positions relative to runways at the major airport. If a track qualifies for a particular runway, the approach monitoring function will check for any violation of the specified final approach area altitude. General Terrain Monitoring is applied to all aircraft that are in the terminal area but are not on approach paths. General Terrain Monitoring is accomplished by comparing a track's reported and predicted altitudes to the minimum altitude assigned to each bin through which the track passes. (Each bin is a square whose sides are two miles long.) All inputs that are required by MSAW come from within the TRACON. All outputs go to controllers within the TRACON. Inputs required by MSAW are:

- o minimum safe altitudes for the areas being checked. Obtained from the ARTS III Adaptation Data Base.

- o aircraft positions, velocities, and altitudes. Obtained from the ARTS III Automatic Tracking Program.

Outputs provided by MSAW are:

- o displayed warnings. Provided on the situation displays of the appropriate controllers.

- o aural warnings. Provided at the sector control positions of the appropriate controllers.

3.1.6.2 Near Term Improvements

Terminal MSAW (See 3.1.6.1) will be implemented in ARTS IIIA systems as they replace ARTS III systems.

3.1.6.3 Far Term Improvements

ATARS Avoidance Advisory Function

An ATARS Avoidance Advisory function is expected to be implemented in the Far Term. It would supplement the MSAW capabilities for detecting unsafe or unacceptable use of airspace. The ATARS Avoidance Advisories would provide pilots and controllers with real-time messages that would allow aircraft to avoid:

- o Terrain (hills, valleys, sloping land),
- o Obstacles (TV towers, microwave relay towers, radio towers, tall buildings), and
- o Special Airspace (Terminal Control Areas, Restricted Airspace, Prohibited Airspace).

The avoidance information would also be needed by ATARS in order to prevent advisories from being given that would maneuver aircraft into terrain, obstacles, or special airspace.

Advisories would be furnished to an ATARS-equipped aircraft whenever it enters restricted airspace, is predicted to be too close to the terrain, or is predicted to be too close to

obstacles. These advisories would be issued on each scan that the alert conditions are satisfied. The advisories are intended to provide the pilot with information concerning the potential problem; they would not attempt to resolve the problem.

Terrain advisories alert the pilot of an aircraft that is in close proximity to the terrain. A terrain alert would be issued if the aircraft is projected to violate the altitude threshold (500 to 1000 feet above the terrain elevation as defined in the ATARS data base) associated with the airspace along the aircraft's projected flight path during the projection time (approximately 30 seconds). Terrain advisories would be suppressed if the aircraft is on a final approach glide slope.

Airspace advisories would be used to notify a pilot that his aircraft has entered restricted airspace. Such an alert would also be issued to an uncontrolled aircraft whenever it is within a Terminal Control Area.

Obstacle avoidance advisories would be issued to an aircraft if it is converging with an obstacle and the aircraft is within a specified distance and altitude of the obstacle.

3.1.6.4 Potential and Longer Range Improvements

A potential improvement is the use of DABS Data Link to uplink MSAW advisories to aircraft.

3.1.7 Traffic Flow Management

3.1.7.1 Current System

Currently, terminal metering personnel manually calculate estimated times of arrival at runways, manually determine desirable spacing and sequencing of aircraft onto the runways, and manually determine the aircraft maneuvers that should be performed in order to achieve the desirable spacing and sequencing.

3.1.7.2 Near Term Improvements

Current plans call for terminal flow management to be enhanced in the Near Term through coordination with the En Route Metering function described in 2.1.7. The terminal metering and sequencing functions performed in TRACONs will continue to be performed manually.

3.1.7.3 Far Term Improvements

In the Far Term, Terminal Sequencing and Spacing (TS&S) is expected to be implemented in some ARTS IIIA TRACONs. TS&S would help controllers control the arrival of aircraft in the terminal area so that safe, efficient use could be made of the runways. TS&S would attempt to have aircraft arrive at the runways in the proper sequence and with proper separation from other arriving and departing aircraft. Through computer software, TS&S would automatically calculate the times of arrival if no actions are taken by controllers, and would also calculate the estimated arrival times that are needed for proper

spacing of aircraft. TS&S would provide terminal controllers with information that would help them plan any maneuvers and speed corrections that may be needed to achieve proper sequencing and spacing of aircraft. TS&S would plan for fuel-efficient descent profiles, and ultimately would include planning for multiple runways, VFR flights, and departures.

The implementable version of TS&S is under development and can not be completely specified at this time. Therefore, the descriptive information in the following paragraphs should be considered very tentative.

Inputs that would be required by TS&S are:

- velocity and current position information. Obtained from ARTS IIIA automatic tracking program.

- aircraft type. Obtained from flight plans from the host ARTCC, adjacent TRACON, etc.

- airport configuration and conditions (arrival and departure runways in use, departure/arrival mix as to volume, adaptation data associated with the airport configuration, arrival spacing requirements, weather data, etc.)

- expected arrival time at terminal metering fix. Obtained from host ARTCC.

Outputs that would be provided by TS&S are:

- o data block information for each metered aircraft. Provided on terminal controllers' situation displays.
  - recommended heading, altitude, and/or speed to which the aircraft should be told to change at this time.
  - landing sequence number, assigned runway, and required separation.
  - number of seconds that the aircraft must be delayed.
  - time of expected departure from meter fix, and hold recommendation indicator.
  - separation alert.
  - an indication of whether or not the aircraft is flying a fuel-efficient descent profile path.
- o tabular data. Provided on terminal controllers' and/or supervisors' situation displays.
  - flight plan information for those aircraft that are expected to arrive in the terminal airspace within the next few minutes.

- a hold indication for each aircraft for which a hold is recommended.

- proposed time of departure from meter fix for each aircraft.

- amount of delay time that should be imposed on each aircraft considering its expected time of arrival at its meter fix.

- real-time wind data calculated from tracking results versus assigned aircraft headings and speeds.

- preview of next maneuvering command that will be presented to controller.

o information to be sent to the host ARTCC.

  - Proposed Time of Departure (PTD) from meter fixes for each arriving aircraft that would require delays greater than the normal control ability of the terminal. Digital data messages for use by En Route Metering.

  - current aircraft acceptance rate for each runway. Digital or voice data for use by En Route Metering.

  - flight information for each terminal aircraft (VFR, Tower En Route, or Departure) or runway slot reservations. Digital or voice data for use by En Route Metering.

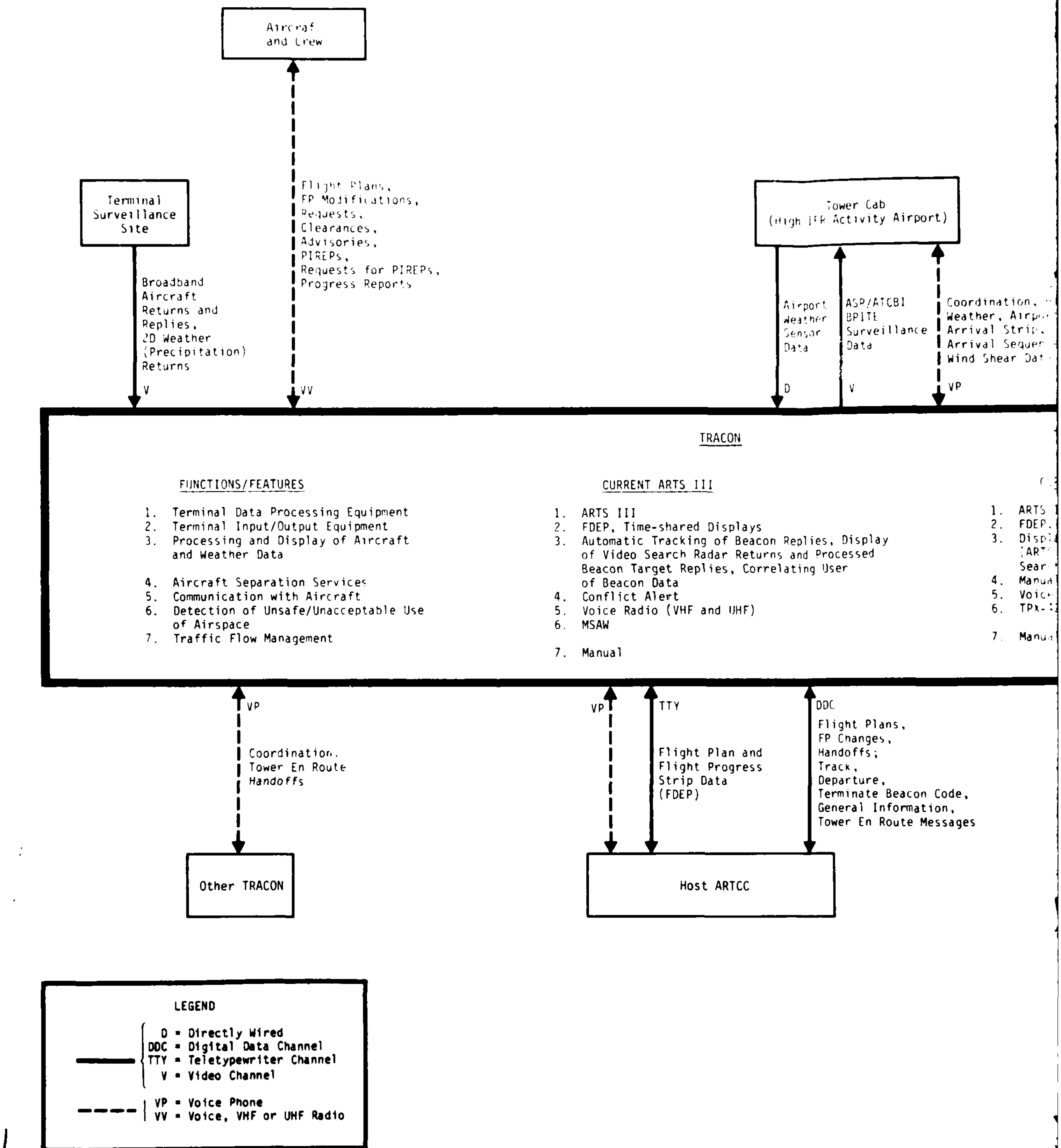
Also in the Far Term, TS&S would be made compatible with the Terminal Conflict Alert Function and En Route Metering. TS&S would be dependent upon En Route Metering's delivery of aircraft to meter fixes within certain coarse time limits. In turn, TS&S would provide En Route Metering with real-time metering and spacing information (runway acceptance rates, runway slot usage, or flight data for VFR flights, Tower En Route flights, and departures) and more timely PTD data to achieve more effective metering. TS&S would also include an automated capability for analysis of the desirability of the use of Profile Descent and other fuel conservation methods for individual aircraft.

3.1.7.4 Potential and Longer Range Improvements

Integrated Flow Management (IFM) is a concept that may be implemented as a longer range improvement. IFM (as described in Reference 2-33) is a planning process that would provide for communications and coordination among the various ATC facilities (Central Flow Control, En Route, TRACON, Tower Cab) to assure the efficient utilization of existing resources to meet the demand imposed on the ATC system. It is concerned with a coordinated and efficient systemwide operation and does not exercise and direct control of individual aircraft. Preliminary work is underway on IFM.

3.2 TRACON Facilities Connectivity

Figures 3-4, 3-5, and 3-6 show respectively, the Current, Near Term, and Far Term connections between an ARTS III(A) TRACON and other elements of the ATC system. The figures do not show the specific connectivity for ARTS II and TPX-42 Facilities. As


Aircraft and Crew
Terminal Surveillance Site
Flight Plans,
FP Modifications,
Requests,
Clearances,
Advisories,
PIREPs,
Requests for PIREPs,
Progress Reports
Broadband Aircraft Returns and Replies,
2D Weather (Precipitation) Returns
V
VV
Tower Cab (High IFR Activity Airport)
Airport Weather Sensor Data
D
ASR/ATCBI BRITE Surveillance Data
V
Coordination,
Weather, Airport
Arrival Strip,
Arrival Sequence
Wind Shear Data
VP
TRACON
FUNCTIONS/FEATURES
1. Terminal Data Processing Equipment
2. Terminal Input/Output Equipment
3. Processing and Display of Aircraft and Weather Data
4. Aircraft Separation Services
5. Communication with Aircraft
6. Detection of Unsafe/Unacceptable Use of Airspace
7. Traffic Flow Management
CURRENT ARTS III
1. ARTS III
2. FDEP, Time-shared Displays
3. Automatic Tracking of Beacon Replies, Display of Video Search Radar Returns and Processed Beacon Target Replies, Correlating User of Beacon Data
4. Conflict Alert
5. Voice Radio (VHF and UHF)
6. MSAW
7. Manual
1. ARTS
2. FDEP,
3. Displ
4. Manual
5. Voice
6. TPX-
7. Manual
VP
Coordination,
Tower En Route
Handoffs
Other TRACON
VP
TTY
Flight Plan and Flight Progress Strip Data (FDEP)
DDC
Flight Plans,
FP Changes,
Handoffs;
Track,
Departure,
Terminate Beacon Code,
General Information,
Tower En Route Messages
Host ARTCC
LEGEND
D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
V = Video Channel
VP = Voice Phone
VV = Voice, VHF or UHF Radio

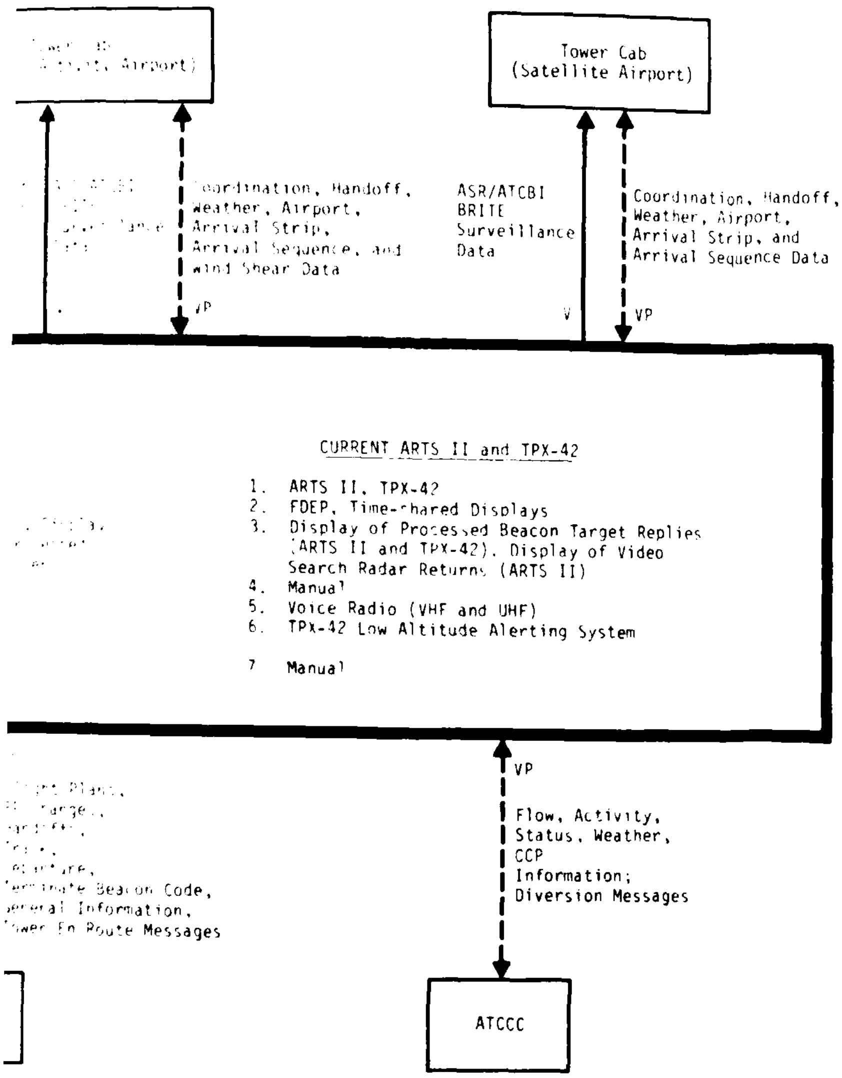
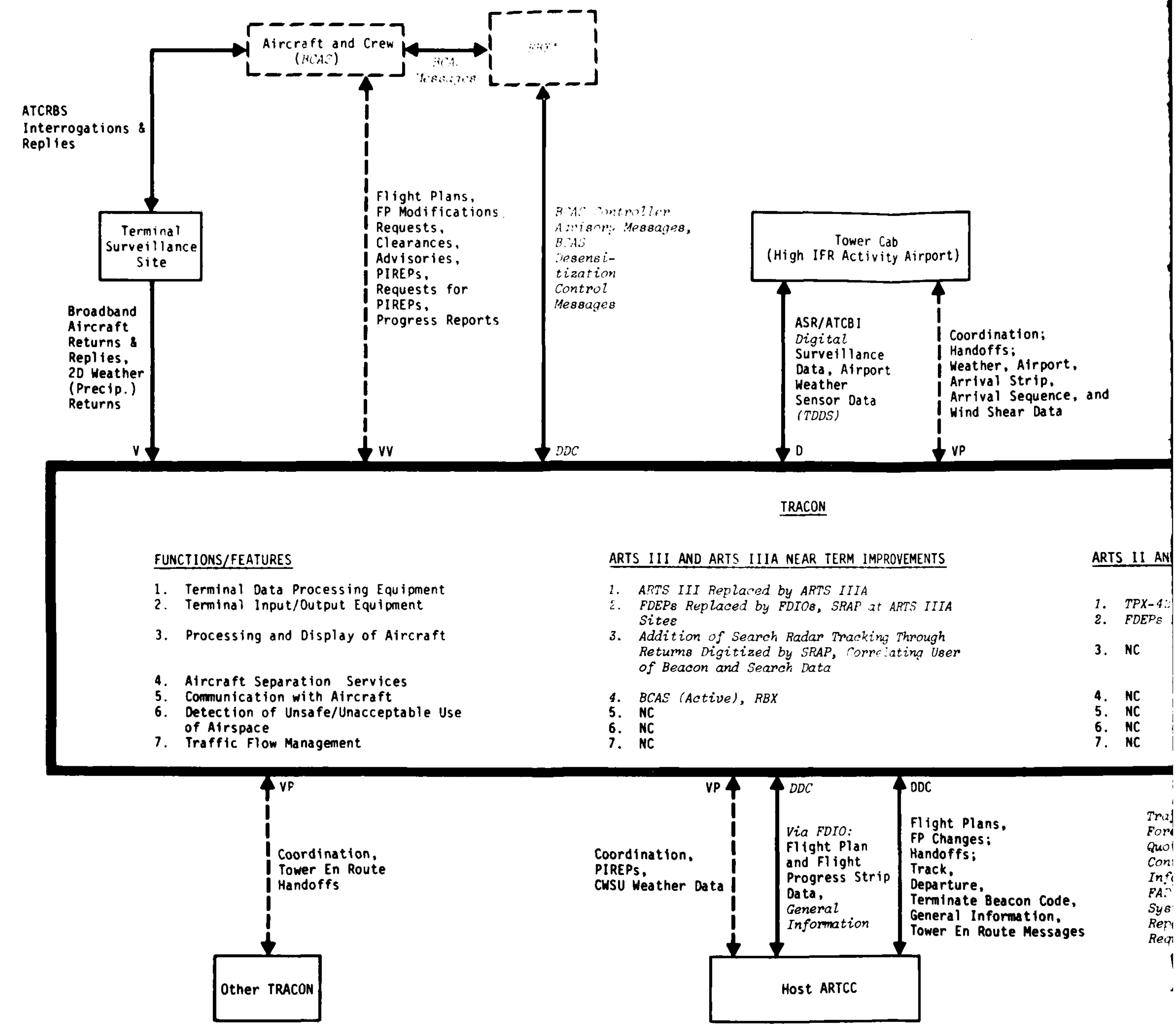


FIGURE 3-4
CURRENT TRACON (ARTS III) CONNECTIVITY DIAGRAM

2



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

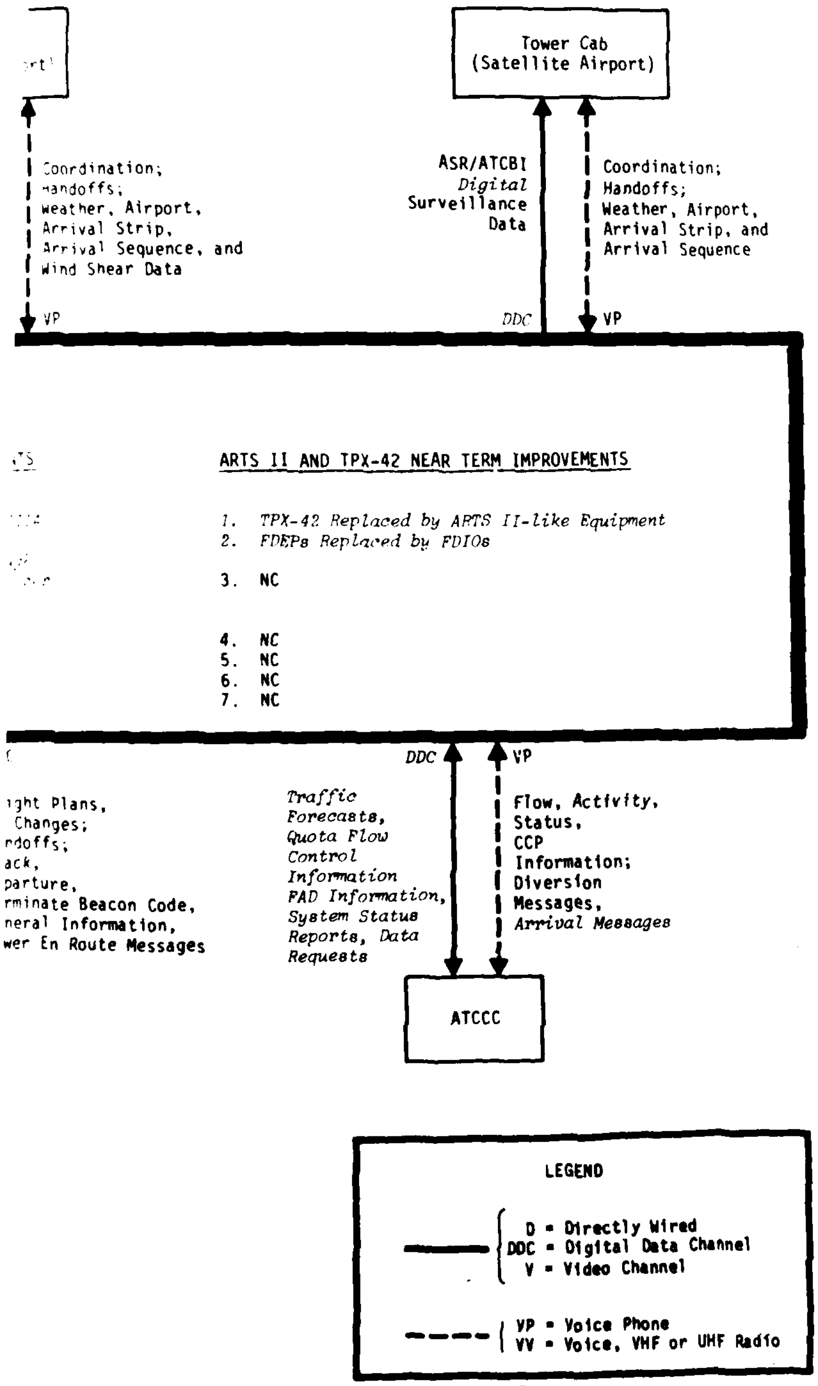
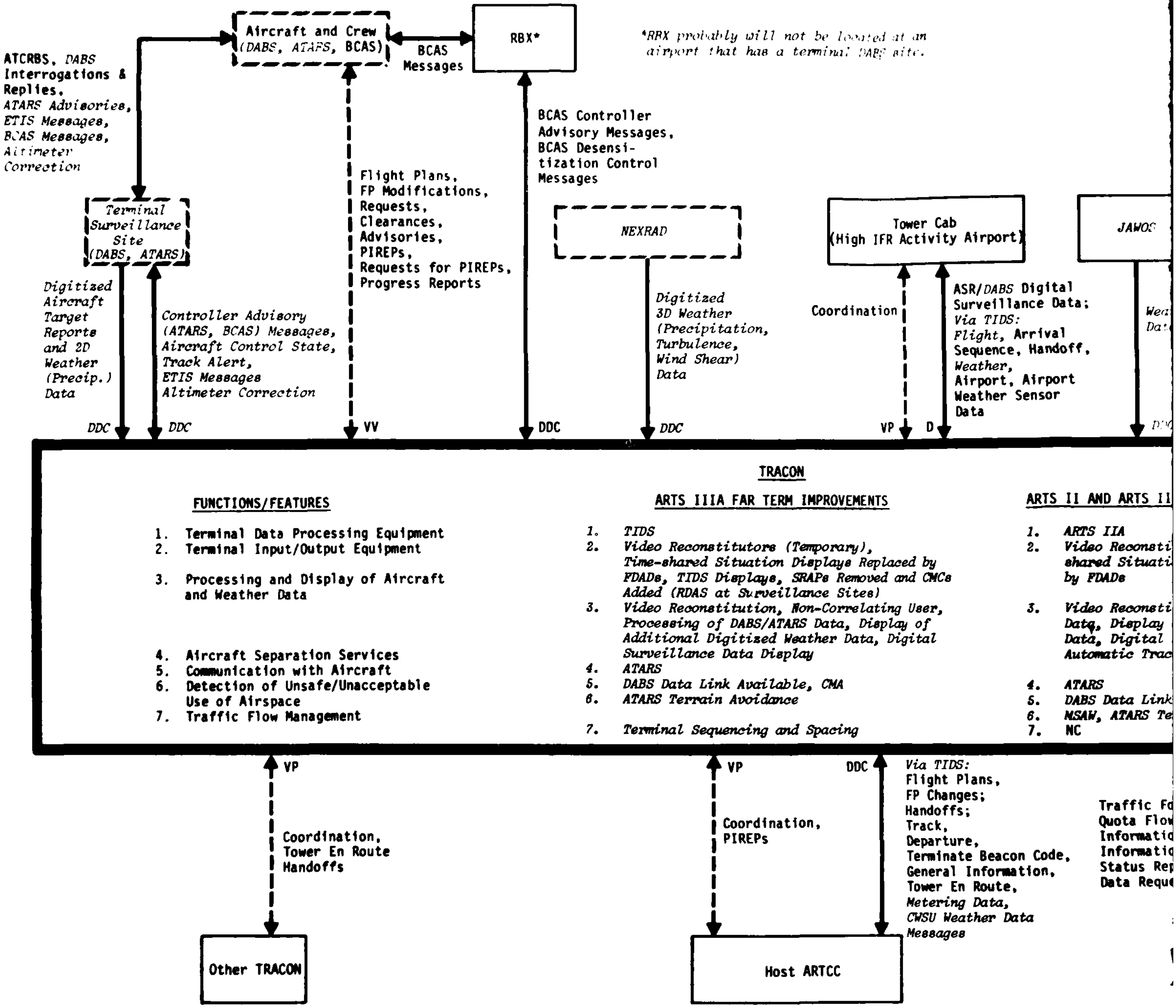


FIGURE 3-5
NEAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

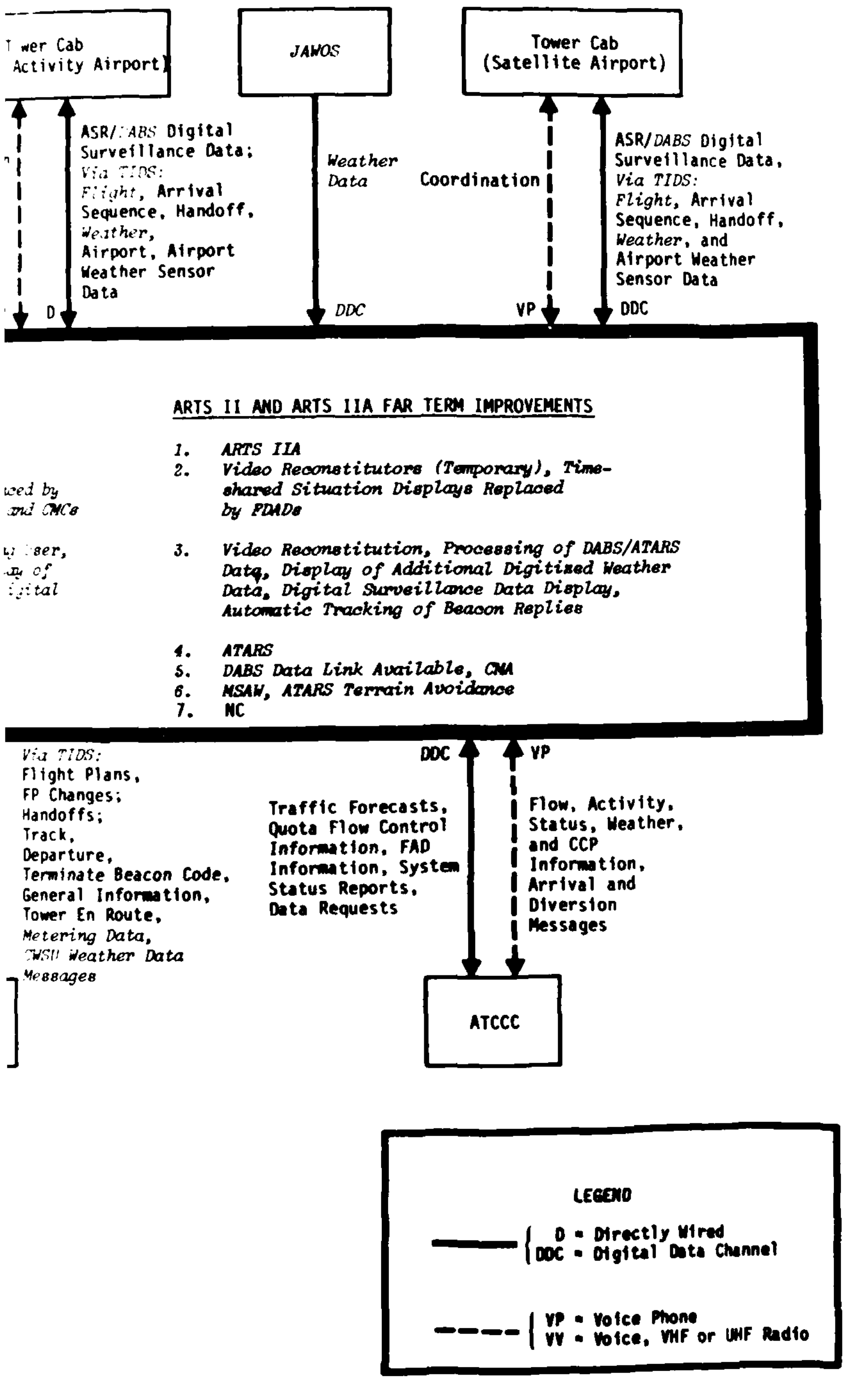


FIGURE 3-6
FAR TERM TRACON (ARTS IIIA) CONNECTIVITY DIAGRAM

previously mentioned, the emphasis in this chapter is on ARTS IIIA TRACONs -- the highest level of terminal automation. The TRACONs and TRACABs that have ARTS II or TPX-42 automation equipment do not have all of the functions and are not connected to all of the elements indicated in the figures. ARTS II functional capability and connectivity are similar to ARTS IIIA but more limited. The capability of TPX-42 equipment is much more limited, and the equipment itself is connected only to terminal surveillance sites.

The principal changes in connectivity from the Current System to the Near Term System are shown in italic type in Figure 3-5. Changes in complete functions and groups of improvements are further emphasized by being enclosed in blocks outlined with heavy broken lines. Similarly, italics and heavy, broken lines are used in Figure 3-6 to indicate the principal changes in connectivity from the Near Term System to the Far Term System. These changes are briefly described in the following paragraphs.

Near Term

It is expected that Radar Beacon Transponders (RBX) will be located at some airports. These would be used to exchange BCAS-related messages between aircraft and TRACONs.

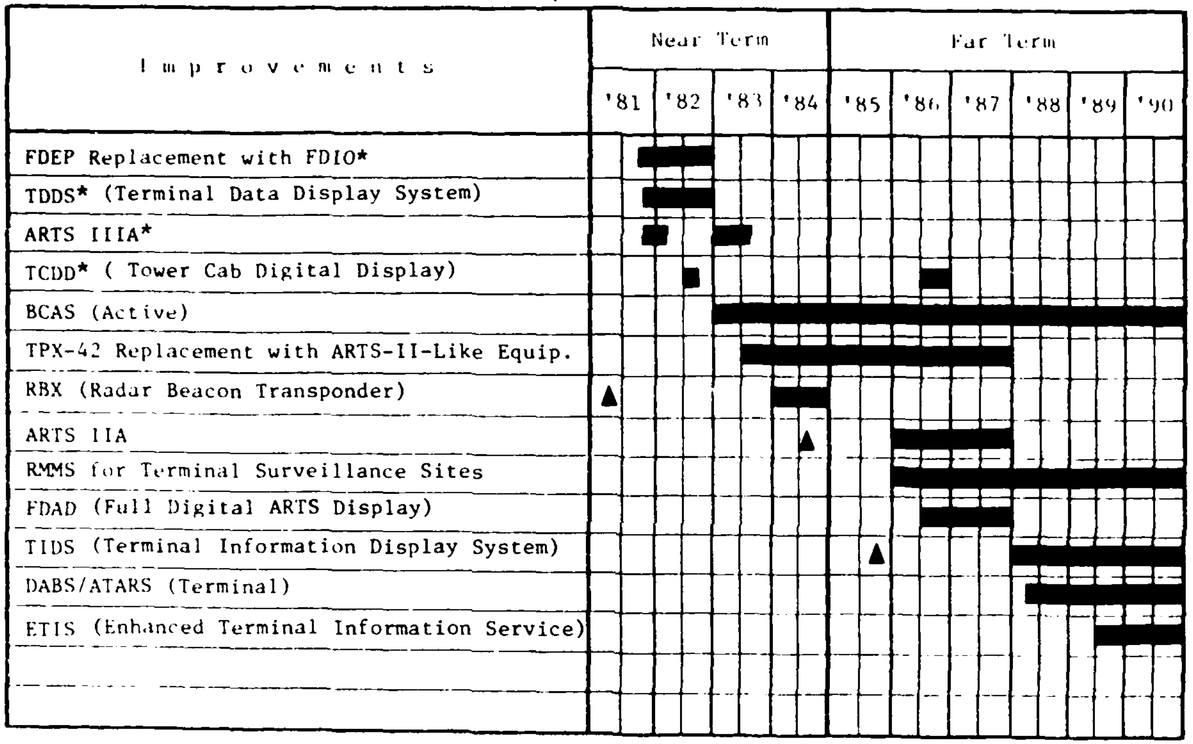
Information on aircraft arrivals and diversions is expected to be sent via voice to the ATCCC (Air Traffic Control Command Center) from the TRACON for use in Central Flow Control calculations. Weather information, especially prepared for use by TRACON controllers, would be available from the CWSU at the host ARTCC. Digital surveillance data would be sent from TRACONs to Tower Cabs for display.

Far Term

In the Far Term, Data Link capabilities are expected to be available through DABS. The TRACON would be able to send messages to the terminal surveillance sites for uplinking to aircraft, and would receive (from the surveillance sites) messages that had been downlinked from aircraft. Controller Alerts generated by ATARS would be sent to the TRACON. Advisory messages could also be sent to the TRACON to show avoidance maneuvers that were recommended to aircraft by ATARS and/or BCAS. A TRACON would receive its principal weather information from NEXRAD. NEXRAD would provide three-dimensional precipitation information plus information on turbulence and wind shear. Metering data would be exchanged between TS&S and En Route Metering. TIDS is expected to be implemented in the Far Term. It would be internal to the TRACON, and would be connected to the ARTS computer, the host ARTCC, adjacent TRACONs, local Tower Cabs, and remote Tower Cabs. Airport status and weather data would be consolidated into TIDS and displayed on special TIDS displays. It is expected that FDADs would be used at ARTS sites. Surveillance data (aircraft and weather) would be received in digital form and would be displayed on the FDADs. It is expected that digital weather information would come from the CWSU at the host ARTCC.

3.3 TRACON Facilities Tentative Implementation Schedule

Figure 3-7 shows the tentative implementation schedule for the principal improvements to the TRACON Facilities. Generally, the schedules for implementation are not schedules that have been approved by FAA management. In many cases, no decision has been



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 3-7
TRACON FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE

made to implement the function. The schedules are based on the best estimates of the times of availability of the Technical Data Packages. The estimates have been obtained from personnel who have been working on the specific functions as well as from budgetary information.

3.4 TRACON Facilities Interface Planning Summary

In the preparation of this chapter, it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a TRACON Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issues cited below were identified during the preparation of this document and were reviewed with the appropriate FAA program managers. Follow-up on these issues was undertaken by a joint Systems Research and Development Service and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in December 1980. The reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions.

The integration issue assumptions pertinent to TRACON Facilities are:

3.4.1 DABS-Related ARTS Software Issues

Issue 202: Use of DABS/ATARS Data by En Route and Terminal Automation Facilities

It was assumed that in the Far Term, ATARS Advisories and DABS data will be sent from Terminal DABS Sites to Terminal ATC Facilities and to some adjacent En Route ATC Facilities. En Route DABS Sites will be implemented as longer range improvements. ATARS Advisories and DABS data will be sent from the En Route DABS Sites to En Route ATC Facilities. En Route and Terminal Automation Facilities will display received advisories to their controllers.

Issue 305: ARTS IIIA Software for the DABS Era

It was assumed that commissionable software to process and display DABS surveillance data and ATARS advisory messages at an ARTS IIIA site will be developed based on the FAATC (FAA Technical Center) TATF (Terminal Automation Test Facility) software used to test DABS. DABS will treat ARTS IIIA as a non-correlating user of surveillance data.

Issue 310: DABS/ATARS at Multi-Beacon ARTS IIIA Sites

It was assumed that DABS and ATARS data from multiple DABS Sites applicable to a particular ARTS IIIA Site will be forwarded and directed to the appropriate control position through ARTS IIIA-based software.

Issue 216: TABG Tracker Coast Processing

It was assumed that the TABG (Threshold Alpha Beta Gamma) tracker will be improved and will be incorporated in the ARTS IIIA software.

3.4.2 DABS-Related Hardware Issues

Issue 302: ARTS II--DABS Interface

It was assumed that Video Reconstitutors will be used to convert digitized surveillance data for display on existing ARTS II time-shared displays. ARTS II software to utilize DABS surveillance data will be developed based on the ARTS IIIA/DABS interface software.

Issue 711: Reconstituted Video for DABS, Search Radar (ARTS IIIA)

It was assumed that Video Reconstitutors will be used at some ARTS IIIA sites to convert DABS surveillance data for display on existing ARTS IIIA time-shared displays. Digital displays will be available at some ARTS sites that receive DABS data during later phases of the DABS implementation.

Issue 317: ARTS IIIA Hardware for Use with DABS

It was assumed that additional processing, storage and communications capabilities will be provided at ARTS IIIA locations to support DABS.

Issue 326: SRAP

It was assumed that when DABS is implemented at a Terminal Surveillance Facility whose search radar does not have the Moving Target Detector capability, a portion of SRAP (Sensor Receiver and Processor) will be installed at the Terminal Surveillance Facility and used as a Radar Data Acquisition System (RDAS) to provide digitized search radar data to DABS. The SRAP at the ARTS site will be removed since ARTS will then receive digitized search data processed by DABS.

Issue 710: ASR-9s at ARTS IIIA sites

It was assumed that the timing of the installation of any ASR-9s at Terminal Surveillance Facilities will be independent of the timing of DABS implementation at those facilities.

3.4.3 ARTS Software Issues

Issue 706: ATARS Advisories on Non-Mode C Aircraft

It was assumed that proximity advisories will be sent to ATARS-equipped aircraft for target aircraft that are Mode A equipped or are tracked by search radar.

Issue 707: ATARS Terrain Avoidance, Terminal MSAW

It was assumed that ATARS will contain an Avoidance Advisory function for Terrain, Obstacles, and Special Airspace. It is further assumed that at some point this function will be merged with terminal MSAW.

Issue 331: AVS - Terminal Sequencing and Spacing

It was assumed that the initial designs of the Terminal Sequencing and Spacing (TS&S) function will operate with fixed sets of longitudinal separation standards between aircraft on final approach. The advanced Vortex System (AVS), a potential improvement, may be developed to permit variable separation standards to increase runway capacity while minimizing the likelihood of aircraft encountering wake vortices. It is assumed that TS&S may be modified to account for variable spacings if required.

3.4.4 Terminal Hardware Issue

Issue 330: TPX-42 Replacement

It was assumed that all TPX-42s will be replaced with ARTS-II-like equipment in the Near Term.

3.4.5 Miscellaneous Issues

Issue 304: ARTS IIIA System Definition and Capabilities

It was assumed that as implemented in the Near Term (pre-1985), ARTS IIIA will provide the following improvements over the capabilities of ARTS III: automatic tracking of search radar targets, fail-soft capability, multi-processing, continuous data recording, more storage capacity than ARTS III, multi-processing, a separate buffer memory for each display, automatic overload sensing and protection, and remote tower display and data entry.

Issue 315: Consolidation of TRACONs

It was assumed that until the en route ATC computer replacement has occurred, TRACON consolidation will be limited to configurations similar to that of the NY TRACON.

Issue 405: Traffic Flow Management

It was assumed that the various advanced systems and automation improvements (e.g., En Route Metering, Terminal Sequencing and Spacing, and Central Flow Control) that are planned for traffic flow management will be implemented as compatible packages.

4. TOWER FACILITIES

This chapter describes the system improvements planned for the Tower Facilities and the interfaces with other ATC facilities for Current, Near Term and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1. The facilities described in this chapter include the ATC facilities that control most of the aircraft operating within an airport traffic area, i.e., within 5 miles of an airport and below 3000 feet AGL, or taxiing on the ground. Functions performed in a Tower Cab related to terminal area traffic control outside the airport traffic area were discussed previously in Chapter 3 and will not be repeated.

In Section 4.1, the current functions and equipment at different types of Tower Cabs are discussed in a general manner, and the Near Term and Far Term improvements are described. Then, a discussion of the anticipated connectivity changes associated with these Tower Cab improvements is given in Section 4.2. This, in turn, is followed by a discussion of the tentative implementation schedule for the improvements in Section 4.3. Section 4.4 summarizes an assumption that was made with regard to interfaces between future tower improvements.

4.1 Tower Cab Improvements

Table 4-1 illustrates the four major types of airports and their associated Air Traffic Control facilities.

- The High IFR Activity Airports are the primary airports associated with an ARTS III TRACON. These airports have a large amount of air traffic that operate in accordance

TABLE 4-1
CURRENT TERMINAL ATC FACILITIES

	Airport Type	TRACON	TRACAB	Tower Cab
	High IFR Activity Airports (ARTS III Primary Airports)	ARTS III Automation (63)	None	67 Airports*
	Medium IFR ACtivity Airports (ARTS II, TPX-42 Primary Airports)	*ARTS II or AN/TPX-42 Automation* (73) (39)		112 Airports
Low IFR Activity Airports	High VFR Activity Airports (VFR Towers, Satellite Airports)	None	None	222 Airports
	Medium and Low VFR Activity Airports (No Control Towers)	None	None	None

*Several of the High IFR Activity Airports share a common TRACON, e.g., JFK, Newark, and La Guardia New York City.

with an IFR flight plan and a relatively small amount of VFR traffic. Currently, about 75% of all air carrier operations take place at this type of airport.

- The Medium IFR Activity Airports are the primary airports associated with an ARTS II or TPX-42 TRACON or TRACAB. In general, these airports have a higher level of VFR traffic and less IFR traffic than the high IFR activity airports, and less total annual activity. Most of the remaining air carrier operations take place at this type of airport.

- The High VFR Activity Airports are either secondary (satellite) airports associated with a TRACON or TRACAB, or they are airports that have a control tower but are not associated with a TRACON or TRACAB. This type of airport has a large amount of VFR traffic and very little IFR traffic. Almost all of the traffic at these airports is small general aviation aircraft.

- The Medium and Low VFR Activity Airports have less VFR traffic and do not have a control tower. While most airports are of this type, the annual activity at these airports is usually very low. In fact, less than half of these airports have either paved runways or runway lights.

4.1.1 Current Tower Cab Functions

Table 4-2 lists the current functions and equipment associated with a Tower Cab at a given type of airport. Not surprisingly,

TABLE 4-2
CURRENT TOWER CAB FUNCTIONS AND EQUIPMENT

Functions	High IFR Activity Airports (ARTS III Primary Airports)	Medium IFR Activity Airports (ARTS II, TPX-42 Primary Airports)	High VFR Activity Airports (VFR Towers, Satellite Airports)
1. Airport Traffic Area Control	ASR/ATCBI BRITE	ASR/ATCBI BRITE	None
2. Runway and Taxiway Control	ASDE-2	None	None
3. Flight Data Handling	FDEP	FDEP	FDEP
4. Weather Data Gathering	Weather Sensors, LLWSAS	Weather Sensors	Weather Sensors
5. Airport, Weather Data Dissemination	ATIS	ATIS	None
6. Airport Lighting Control	Airport Lights	Airport Lights	Airport Lights

while the functions performed at all Tower Cabs are similar, the highest level of equipment exists at the high IFR activity airports - all of the other airport types have a subset of this equipment. Each Tower Cab performs the six functions described below.

Airport Traffic Area Control

Air traffic controllers in the Tower Cab control traffic within the airport traffic area. Visual surveillance of the aircraft under control is normally used whenever possible. However, when aircraft are beyond visual range, or the visibility is restricted due to the weather or time of day, then the controllers utilize the ASR/ATCBI BRITE Display for surveillance information. Voice communications between the controllers and the aircraft is accomplished by VHF or UHF radio. Civilian aircraft utilize VHF voice communications and military aircraft utilize VHF or UHF voice communications.

Runway and Taxiway Control

This function includes the control of aircraft exiting the runway after touchdown, granting taxi clearances for arrivals and departures, holding aircraft for departure or an available gate, granting takeoff clearances, assuring runway clearance for runway operations and providing safe taxiway flow management. Visual surveillance of aircraft on the airport surface is augmented at some high IFR activity airports by Airport Surface Detection Equipment (ASDE-2) . The controllers in the Tower Cab use an ASDE Display to locate aircraft on the airport's surface (including runways, taxiways and apron areas) when the visibility conditions are poor.

Flight Data Handling

Flight plan data on arriving aircraft is forwarded from the ARTCC to the Tower Cab and printed out on the Flight Data Entry and Printout (FDEP) equipment, and messages on departing aircraft are sent from the Tower Cab to the ARTCC via FDEP.

Weather Data Gathering

Weather information, including data on the wind, barometric pressure, temperature, ceiling, and visibility, is periodically gathered at the airport either by personnel in the Tower Cab or at an associated Flight Service Station or National Weather Service (NWS) office and forwarded to other ATC and NWS facilities. In addition, during periods of rapid change in the weather, special observations are made.

Sudden changes in the wind due to updrafts and downdrafts are detected by the Low Level Wind Shear Alert System (LLWSAS) at most high IFR activity airports. The LLWSAS uses wind sensors deployed around the airport's periphery and at the airport's center to measure the wind's magnitude and direction. When the LLWSAS Processor (located in the tower) detects a vector difference of 15 knots or more between the wind velocity at any peripheral sensor and the center sensor, the controllers in the Tower Cab are notified by the LLWSAS Display that a wind shear condition is present.

Tower Cab controllers also receive weather information from Pilot Weather Reports (PIREP). These verbal reports, via VHF or UHF radio communications, include airborne weather conditions or runway/taxiway surface conditions. PIREPs can be requested by

the controller or volunteered by the pilot.

Airport, Weather Data Dissemination

Information on the weather and the status of the airport's navigation aids and runways is forwarded to aircraft operating in the terminal area either automatically through continuously broadcasted Automatic Terminal Information Service (ATIS) messages pre-recorded in the Tower Cab, or by the air traffic controllers.

Airport Lighting Control

Air traffic controllers in the Tower Cab are also responsible for adjusting the intensity of the approach, runway, and taxiway lighting systems to optimize their performance under the current visibility conditions at the airport.

4.1.2 Near Term Tower Cab Improvements

As shown in Table 4-3 and Figures 4-1, 4-2 and 4-3, six significant improvements are anticipated in the Near Term.

Tower Cab Digital Display (TCDD)

TCDDs will replace the existing BRITE Displays and improve the presentation of surveillance information in the Tower Cabs at a few high IFR activity airports in the Near Term, and more airports in the Far Term. In addition, because the TCDDs will use narrowband digital data instead of broadband video, some high VFR activity airports (that are also secondary [satellite]

TABLE 4-3
TOWER CAB IMPROVEMENTS SUMMARY

	Functions	Current System (1980)	Near Term Improvements (1981-1984)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
High IFR Activity Airports (ARTS III Primary Airports)	1. Airport Traffic Area Control	ASR/ATCBI BRITE	TCDD*	NC	AVS, DABS Data Link
	2. Runway and Taxiway Control	ASDE-2	NC	ASDE-3	TAGS, RCMS
	3. Flight Plan Handling	FDEP	FDIO*	TIDS	
	4. Weather Data Gathering	LLWSAS Weather Sensors	AWSS TDDS*	NEXRAD TIDS, JAWOS	FAA Terminal Weather Radar
	5. Airport, Weather Data Dissemination	ATIS	CGATIS	ETIS	
	6. Airport Lighting Control	Tower Panel	NC	TIDS	
Medium IFR Activity Airports (ARTS II, TPX-42 Primary Airports)	1. Airport Traffic Area Control	ASR/ATCBI BRITE	NC	NC	TCDD
	3. Flight Plan Handling	FDEP	FDIO*	NC	TIDS
	4. Weather Data Gathering	Weather Sensors NA	NC AWSS	JAWOS NC	TIDS
	5. Airport, Weather Data Dissemination	ATIS	CGATIS	ETIS	
High VFR Activity Airports (VFR Towers, Satellite Airports)	1. Airport Traffic Area Control	NA	TCDD*	NC	
	3. Flight Plan Handling	FDEP	FDIO*	NC	TIDS
	4. Weather Data Gathering	Weather Sensors	NC	JAWOS	TIDS
	5. Weather Data Dissemination	NA	NC	JAWOS	
Medium VFR Activity Airports (No Control Towers)	1. Airport Traffic Area Control	NA	NA	NA	AAAS
	4. Weather Data Gathering	NA	WAVE	JAWOS	
	5. Weather Data Dissemination	NA	WAVE	JAWOS	

ABBREVIATIONS

*	Approved by the FAA for Implementation	LLWSAS	Low Level Wind Shear Alert System
AAAS	Automated Airport Advisory System	NA	Not Applicable
ASDE	Airport Surface Detection Equipment	NC	No Change Included in Current Plans
ATIS	Automatic Terminal Information Service	NEXRAD	Next Generation Weather Radar
AVS	Advanced Vortex System	RCMS	Runway Configuration Management System
AWSS	Airborne Wind Shear System	TAGS	Tower Automated Ground Surveillance
CGATIS	Computer-Generated ATIS	TCDD	Tower Cab Digital Display
ETIS	Enhanced Terminal Information Service	TDDS	Terminal Data Display System
FDEP	Flight Data Entry and Printout Equipment	TIDS	Terminal Information Display System
FDIO	Flight Data Input Output	WAVE	Wind and Altimeter Voice Equipment
JAWOS	Joint Automated Weather Observation System		

INPUTS

From Weather Sensors
- Wind, Pressure, Temperature, Ceiling, and Visibility Data

From TRACON
- Coordination
- Arrival Sequence Data and Arrival Flight Progress Strip Data
- Handoffs
- Weather Data
- ASR/ATCBI Surveillance

From ARTCC
- Flight Plan and Flight Progress Strip Data (FDEP)

From ASDE-2
- Broadband (Video) Aircraft Returns (Range, Azimuth)

From LLWSAS Sensors
- Wind Data

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPS
- Requests for Information
- Progress Reports

From Ground Vehicles
- Requests for Clearances

From Flight Service Station (FSS) or National Weather Service (NWS)
- Weather Data

From ATCCC
- Requests for Situation Reports
- Arrival and Departure Delay Predictions
- Assistance in Handling Calamities or Impending Calamities

Current Tower Cab (High IFR Activity Airport)

FUNCTIONS

1. Airport Traffic Area Control (ASR/ATCBI Brite)
   - Issue Takeoff and Landing Clearances
   - Maintain Safe Separation Distances Between Aircraft
   - Emergency Assistance
2. Runway and Taxiway Control (ASDE-2)
   - Issue Commands to Taxiing Aircraft
   - Control Ground Vehicles on Runways and Taxiways
3. Flight Data Handling (FDEP)
   - Receive Flight Data from ARTCC
   - Deliver Instrument Clearances to Departing Aircraft
4. Weather Data *Gathering* (Weather Sensors, LLWSAS)
   - Record Hourly Surface Weather Data
   - Record Airport Visibility Data
   - Request PIREPS
   - Monitor Wind Shear
5. Airport, Weather Data Dissemination (ATIS)
   - Record and Forward Airport, Weather Data
6. Airport Lighting Control
   - Control Approach, Runway and Taxiway Lights

OUTPUTS

To TRACON
- Coordination
- Handoffs
- Weather and Airport Data
- Wind Shear Data

To ARTCC
- Flight Plan Data (FDEP)

To VOR or VHF/UHF Transmitter
- Recorded ATIS Message (Airport, Weather Data)

To Aircraft (Air Crew)
- Clearance
- FP Modification
- Instructions, Advisories
- Requests for PIREPS

To Ground Vehicles
- Clearances
- Instructions, Advisories

To Flight Service Station (FSS)
- Weather, Airport Data

To National Weather Service (NWS)
- Weather Data

To Airport Lights
- Adjustments for Approach, Runway and Taxiway Light Intensity

To ATCCC
- Situation Reports
- Requests for Assistance in Handling Calamities or Impending Calamities
- Diversion Messages

FIGURE 4-1
CURRENT TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS) INFORMATION FLOW DIAGRAM

INPUTS

From Weather Sensors
- Wind, Pressure, Temperature, Ceiling, and Visibility Data

From TRACON
- Coordination
- Arrival Sequence Data and Arrival Flight Progress Strip Data
- Handoffs
- Weather Data (TDDS)
- ASR/ATCBI Digital Surveillance Data

From ARTCC
- Flight Plan and Flight Progress Strip Data (FDIO)

From ASDE-2
- Broadband (Video) Aircraft Returns (Range, Azimuth)

From LLWSAS Sensors
- Wind Data

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPS
- Requests for Information
- Progress Reports

From Ground Vehicles
- Requests for Clearances

From Automated Flight Service Station (AFSS) or National Weather Service (NWS)
- Weather

From ATCCC
- Requests for Situation Report
- Arrival and Departure Delay Predictions
- Assistance in Handling Calamities or Impending Calamities

Near Term Tower Cab (High IFR Activity Airport)

FUNCTIONS

1. Airport Traffic Area Control (TCDD)
   - Issue Takeoff and Landing Clearances
   - Maintain Safe Separation Distances Between Aircraft
   - Emergency Assistance
2. Runway and Taxiway Control
   - Issue Commands to Taxiing Aircraft
   - Control Ground Vehicles on Runways and Taxiways
3. Flight Data Handling (FDIO)
   - Receive Flight Data from ARTCC
   - Deliver Instrument Clearances to Departing Aircraft
4. Weather Data Gathering (TDDS)
   - Record Hourly Surface Weather Data
   - Record Airport Visibility Data
   - Request PIREPS
   - Monitor Wind Shear
5. Airport, Weather Data Dissemination (CGATIS, MLS Auxiliary Data)
   - Record and Forward Airport, Weather Data
6. Airport Lighting Control
   - Control Approach, Runway and Taxiway Lights

Note: Changes from the Current System to the Near Term are indicated by underlining.

OUTPUTS

To TRACON
- Coordination
- Handoffs
- Weather and Airport Data
- Airport Weather Sensor Data (TDDS)
- Wind Shear Data

To ARTCC
- Flight Plan Data (FDIO)

To VOR or VHF/UHF Transmitter
- Recorded CGATIS Message (Airport, Weather Data)

To Aircraft (Air Crew)
- Clearances
- FP Modification
- Instructions, Advisories
- Requests for PIREPS

To MLS
- MLS Auxiliary Data (Runway, Visibility Conditions)

To Ground Vehicles
- Clearances
- Instructions, Advisories

To Automated Flight Service Station (AFSS)
- Weather, Airport Data

To National Weather Service (NWS)
- Weather Data

To Airport Lights
- Adjustments for Approach, Runway and Taxiway Light Intensity

To ATCCC
- Situation Reports
- Requests for Assistance in Handling Calamities or Impending Calamities
- Diversion Messages

FIGURE 4-2
NEAR TERM TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS)
INFORMATION FLOW DIAGRAM

INPUTS

From Weather Sensors
- Wind, Pressure, Temperature, Ceiling, and Visibility Data

From TRACON
- Coordination
- Arrival Sequence Data and Flight Data (TIDS)
- Handoffs (TIDS)
- Weather Data (TIDS)
- ASR/DABS Digital Surveillance Data

From ASDE-3
- Broadband (Video) Aircraft Returns (Range, Azimuth)

From NEXRAD
- Wind Shear Data

From Aircraft (Air Crew)
- Flight Plans, Requests for FP Changes
- Requests for Clearances
- PIREPS
- Requests for Information
- Progress Reports

From Ground Vehicles
- Requests for Clearances

From AFSS or NWS
- Weather Data

From ATCSS
- Requests for Situation Report
- Arrival and Departure Delay Predictions
- Assistance in Handling Calamities or Impending Calamities

From TAWIS
- Weather Data

Far Term Tower Cab (High IFR Activity Airport)

FUNCTIONS

1. Airport Traffic Area Control (TCDD)
   - Issue Takeoff and Landing Clearances
   - Maintain Safe Separation Distances Between Aircraft
   - Emergency Assistance
2. Runway and Taxiway Control (ASDE-3)
   - Issue Commands to Taxiing Aircraft
   - Control Ground Vehicles on Runways and Taxiways
3. Flight Data Handling (TIDS)
   - Receive Flight Data from TRACON
   - Deliver Instrument Clearances to Departing Aircraft
4. Weather Data Gathering (NEXRAD, TIDS, TAWOS)
   - Record Hourly Surface Weather Data (TIDS, TAWOS)
   - Record Airport Visibility Data (TIDS, TAWOS)
   - Request PIREPS
   - Monitor Wind Shear (NEXRAD)
5. Airport, Weather Data Dissemination (TIDS)
   - Record and Forward Airport, Weather Data
6. Airport Lighting Control (TIDS)
   - Control Approach, Runway and Taxiway Lights

Note: Changes from the Near Term to the Far Term are indicated by underlining.

OUTPUTS

To TRACON
- Coordination
- Handoffs (TIDS)
- Weather, Airport Data (TIDS)
- Airport Weather Sensor Data (TIDS)
- Wind Shear Data (NEXRAD)

To VOR or VHF/UHF Transmitter
- Recorded ATIS Message (Airport, Weather Data)

To Aircraft (Air Crew)
- Clearances
- FP Modifications
- Instructions, Advisories
- Requests for PIREPS

To MLS
- MLS Auxiliary Data (Runway, Visibility Conditions)

To Ground Vehicles
- Clearances
- Instructions, Advisories

To Automated Flight Service Station (AFSS)
- Weather, Airport Data

To National Weather Service (NWS)
- Weather Data

To Airport Lights
- Adjustments for Approach, Runway and Taxiway Light Intensity (TIDS)

To ATCCC
- Requests for Situation Report
- Arrival and Departure Delay Predictions
- Assistance in Handling Calamities or Impending Calamities
- Diversion Messages

FIGURE 4-3
FAR TERM TOWER CAB FACILITIES (HIGH IFR ACTIVITY AIRPORTS) INFORMATION FLOW DIAGRAM

airports associated with an ARTS IIIA TRACON) may be equipped with a TCDD. This assumes that adequate surveillance coverage will be available from the surveillance site located at the primary airport.

Flight Data Input Output (FDIO)

The existing 75 bps FDEP equipment will be replaced with FDIO printers, keyboards and electronic tabular displays to handle flight plan data. FDIO will have a much higher data rate between the ARTCC and the Tower Cab (2400 bps), thus improving the flow of flight plan data. In addition, the FDIO printers are expected to reduce the amount of maintenance required in comparison with the FDEP printers.

Airborne Wind Shear System (AWSS)

Air carrier aircraft will be equipped with an airborne wind shear detection system which will allow them to detect the presence of wind shear while they are landing or taking off.

Terminal Data Display System (TDDS)

TDDSs will be installed at high IFR activity airports to display local and national weather information for use in the Tower Cab and the TRACON. A TDDS will consist of a keyboard, processor, and several electronic tabular displays.

Computer - Generated ATIS (CGATIS)

CGATIS will replace the existing ATIS equipment at medium and

high IFR activity airports. It will convert the airport and weather data, entered manually by the controllers in the Tower Cab, into continuously broadcasted, computer-generated voice transmissions. The transmissions will be automatically sent to the pilots flying in the area.

Wind and Altimeter Voice Equipment (WAVE)

WAVE will be installed at some medium VFR activity airports to automatically provide wind and altimeter setting data to pilots executing an instrument approach. The computer-generated voice data will be sent via a VOR, NDB or some other VHF transmitter.

4.1.3 Far Term Tower Cab Improvements

In the Far Term, five significant improvements are tentatively being considered by the FAA.

Airport Surface Detection Equipment (ASDE-3)

The existing vacuum tube ASDE-2s may be replaced with solid state ASDE-3s with an improved surveillance display. In addition, ASDE-3s may be installed at a number of high IFR activity airports that currently do not have an ASDE.

Terminal Information Display System (TIDS)

The FAA may replace the FDIO and TDDS equipment in all high IFR activity airport Tower Cabs with TIDS equipment in order to eliminate the need for flight progress strips by utilizing electronic tabular displays, and to consolidate weather and

status information in the Tower Cab.

TIDS would consist of a TIDS Processor located in the tower and TIDS Displays located in the TRACON and Tower Cab. The TIDS Processor would interface with the ARTS IIIA Processor, the ARTCC, and the TIDS Displays, and would control the flow of flight plan and weather data between them.

TIDS would also display weather information gathered from ground sources and pilot reports, (PIREPs), and status information for use by the controllers in the Tower Cab and TRACON. The status information would indicate the current status of the airport's Communications, Surveillance and Navigation facilities.

In addition, TIDS might be used to control the intensity of the airport's lighting systems. Additional information on TIDS is contained in Chapter 3.

Next Generation Weather Radar (NEXRAD)

Since the Low Level Wind Shear Alert System (LLWSAS) relies upon wind measurements taken near ground level, it can only detect horizontal wind shear created by gust fronts or cold fronts. To increase the safety of approaches and takeoffs, surveillance low level wind conditions in the entire arrival and departure zones is required. This requirement is beyond any anemometer technique yet developed. Thus, NEXRAD (Reference 4-1) would be used to supplement the LLWSAS information by directly measuring the wind shear condition along the approach path. It would detect both types of wind shear, provided that precipitation is present - it would not be able to detect clear air wind shear.

(See Chapter 7 for a discussion of NEXRAD.)

The wind shear data would be sent from NEXRAD to the TIDS Processor in the Tower Cab, and thus, the controllers in the Tower Cab would be alerted to the presence of hazardous wind shear conditions by the TIDS Display.

Joint Automated Weather Observation System (JAWOS)

JAWOSs will be installed at some medium and high VFR activity airports. At the high VFR activity airports that have been designated as Limited Aviation Weather Reporting Stations (LAWRSs), they will be used to aid the controllers in the Tower Cab by automatically gathering local weather information and distributing it to other ATC and NWS facilities via NADIN.

At some medium VFR activity airports, JAWOSs will be used to automatically gather local weather information and then broadcast it to pilots executing an instrument approach. A VOR, NDB or some other VHF transmitter will be used to transmit the computer-generated voice transmissions to the aircraft. The weather data will also be forwarded to other ATC and NWS facilities via NADIN.

JAWOS will functionally replace several previous weather programs, i.e., the Semi-Automated Meteorological Observation System (SAMOS), the Automated Low-cost Weather Observation System (ALWOS), and the Aviation Automated Weather Observation System (Av-AWOS). Thus, one of these JAWOS systems will be selected for a particular site depending upon the local requirements for weather information. Each site might include

data on the wind, temperature, ceiling, visibility, and barometric pressure.

Enhanced Terminal Information Service (ETIS)

The FAA might install JAWOS systems at some medium and high IFR activity airports to automatically gather weather information and send it to the CGATIS and the TRACON or TRACAB. The CGATIS would use the information to replace the manually entered data supplied by the controllers in the Tower Cab.

The TRACON or TRACAB might eventually use the JAWOS weather data as an input to a DABS Applications Processor. The Processor would send ETIS messages to the pilot via the DABS data link.

4.1.4 Potential and Longer Range Tower Cab Improvements

Beyond these anticipated Far Term improvements, the FAA is tentatively exploring six other improvements.

Advanced Vortex System (AVS)

Aircraft in flight generate counter-rotating wake vortices that trail from their wing tips. Since the strength of these vortices is directly related to the weight of the aircraft, the utilization of large wide body jet aircraft in recent years has created a potential safety problem in the vicinity of airports where aircraft follow other aircraft at relatively close distances. The FAA has temporarily adjusted to this problem by adopting greater longitudinal separation (3 to 6 nautical miles) between arriving aircraft under IMC conditions as a function of

aircraft type.

To improve safety and minimize delays at some high IFR activity airports, the FAA might install an AVS at the airports. AVS, at least initially, may not detect the presence of the wake vortices but rather the magnitude and direction of the wind. It would then estimate whether the current wind conditions were strong enough to dissipate or move these vortices away from the approach path. AVS might be able to reduce the longitudinal separation between arriving aircraft to 3 nautical miles for all types of aircraft when the wind's magnitude exceeds a threshold value which varies as a function of wind direction.

DABS Data Link Messages

The DABS data link might be used at some high IFR activity airports to send clearance delivery and takeoff clearance messages. This assumes that adequate surveillance coverage from a Terminal Surveillance Site is available.

Tower Automated Ground Surveillance (TAGS) System

TAGS (Reference 4-2) is envisioned for possible use at a few high IFR activity airports in order to display flight identity information on surface aircraft that are transponder equipped. This information would be placed on the ASDE Display in addition to the ASDE-3 search radar data.

Runway Configuration Management System (RCMS)

RCMS might be used to reduce delays by providing information to

supervisors in the Tower Cab or TRACON on the availability and traffic handling characteristics of various runway configurations. It would probably be intefaced with TIDS.

FAA Terminal Weather Radar

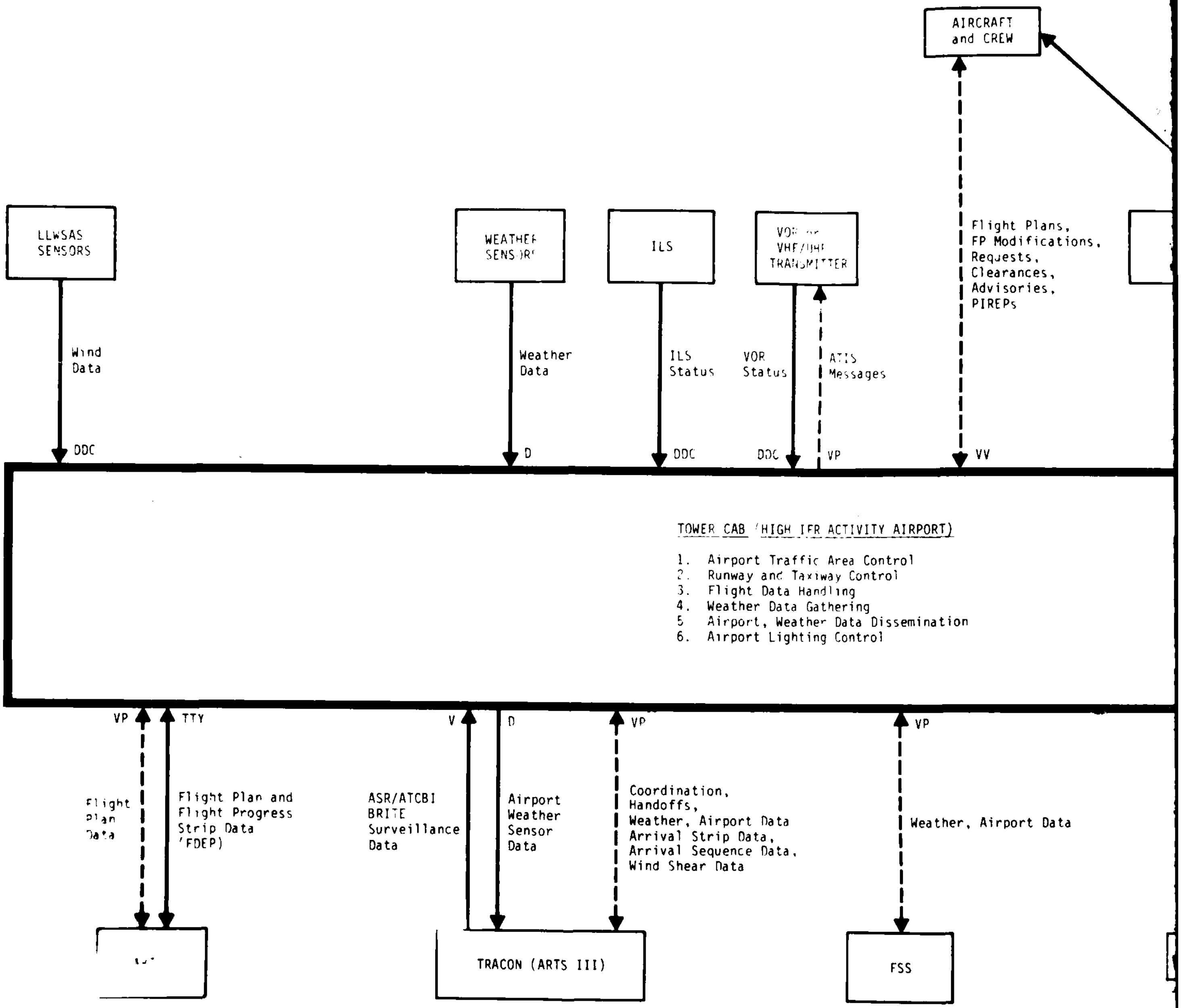
FAA Terminal Weather Radars may be used at some high IFR activity airports if NEXRADs can't be installed there. They would be used to provide local weather information for the TRACON and Tower Cab, including wind shear.

Automated Airport Advisory System (AAAS)

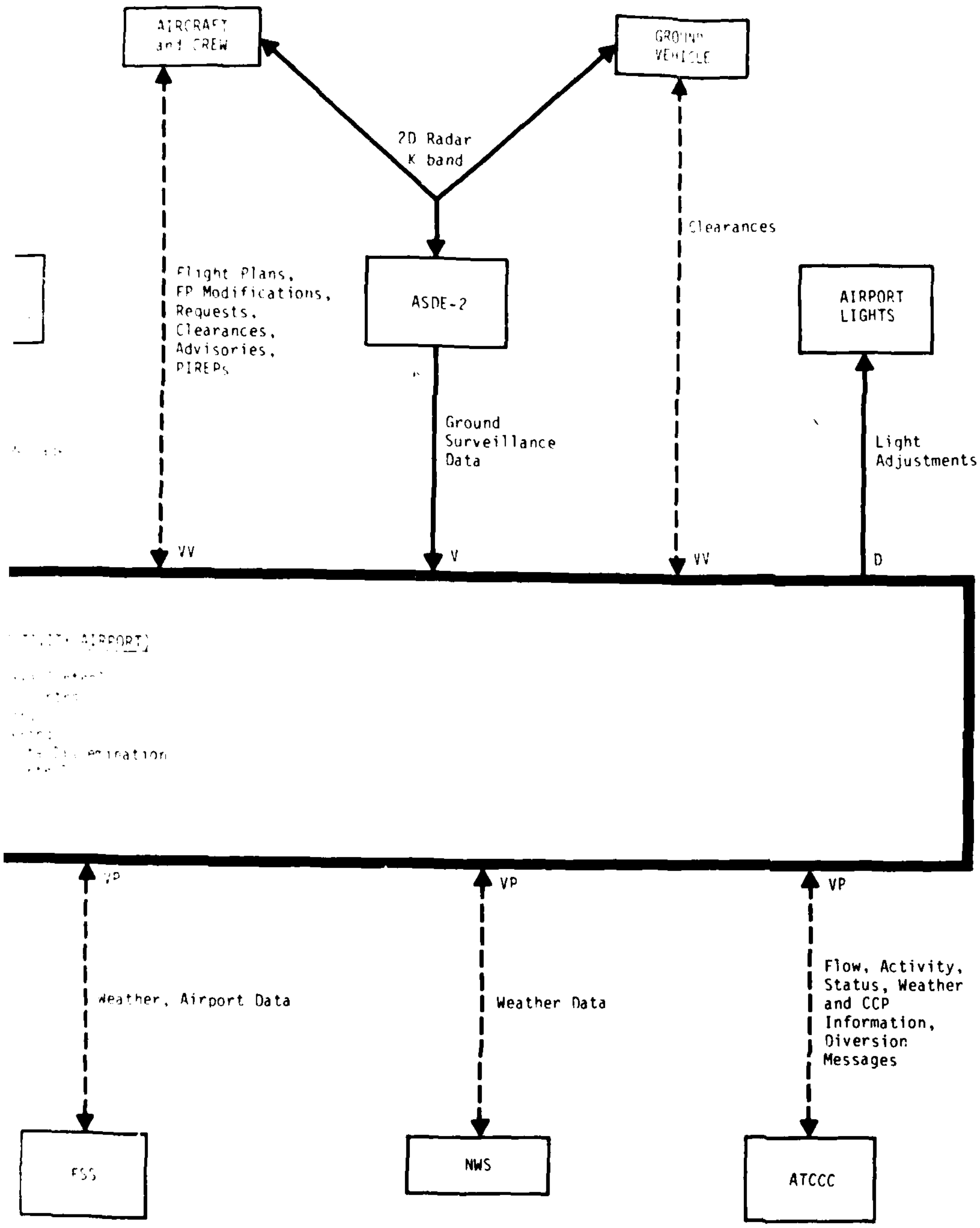
The AAAS, previously known as the Automated Terminal Service (ATS), would consist of a surveillance system (either a search radar and/or a beacon radar) and a AAAS Processor. The AAAS Processor would digitally process the surveillance data and issue advisories to arriving and departing aircraft either by computer-generated voice messages or a DABS data link. The advisories would be used to improve aircraft safety in the vicinity of an airport without a Tower Cab at a lower cost than the installation of a Tower Cab, or to provide services at off-hours at an airport with a Tower Cab instead of adding an additional shift of controllers.

4.2 Tower Cab System Connectivity

Connectivity diagrams specify the kinds of messages sent between ATC facilities, and the communications media used (e.g., directly wired, digital data channel, teletypewriter channel, etc.). Figures 4-4, 4-5, and 4-6 illustrate the current



AIRCRAFT and CREW
LLWSAS SENSORS
WEATHER SENSORS
ILS
VOR or VHF/UHF TRANSMITTER
Flight Plans, FP Modifications, Requests, Clearances, Advisories, PIREPs
Wind Data
DDC
Weather Data
D
ILS Status
DDC
VOR Status
DDC
ATIS Messages
VP
VV
TOWER CAB (HIGH IFR ACTIVITY AIRPORT)
1. Airport Traffic Area Control
2. Runway and Taxiway Control
3. Flight Data Handling
4. Weather Data Gathering
5. Airport, Weather Data Dissemination
6. Airport Lighting Control
VP
TTY
Flight Plan Data
Flight Plan and Flight Progress Strip Data (FDEP)
V
D
ASR/ATCBI BRITE Surveillance Data
Airport Weather Sensor Data
VP
Coordination, Handoffs, Weather, Airport Data Arrival Strip Data, Arrival Sequence Data, Wind Shear Data
VP
Weather, Airport Data
TRACON (ARTS III)
FSS



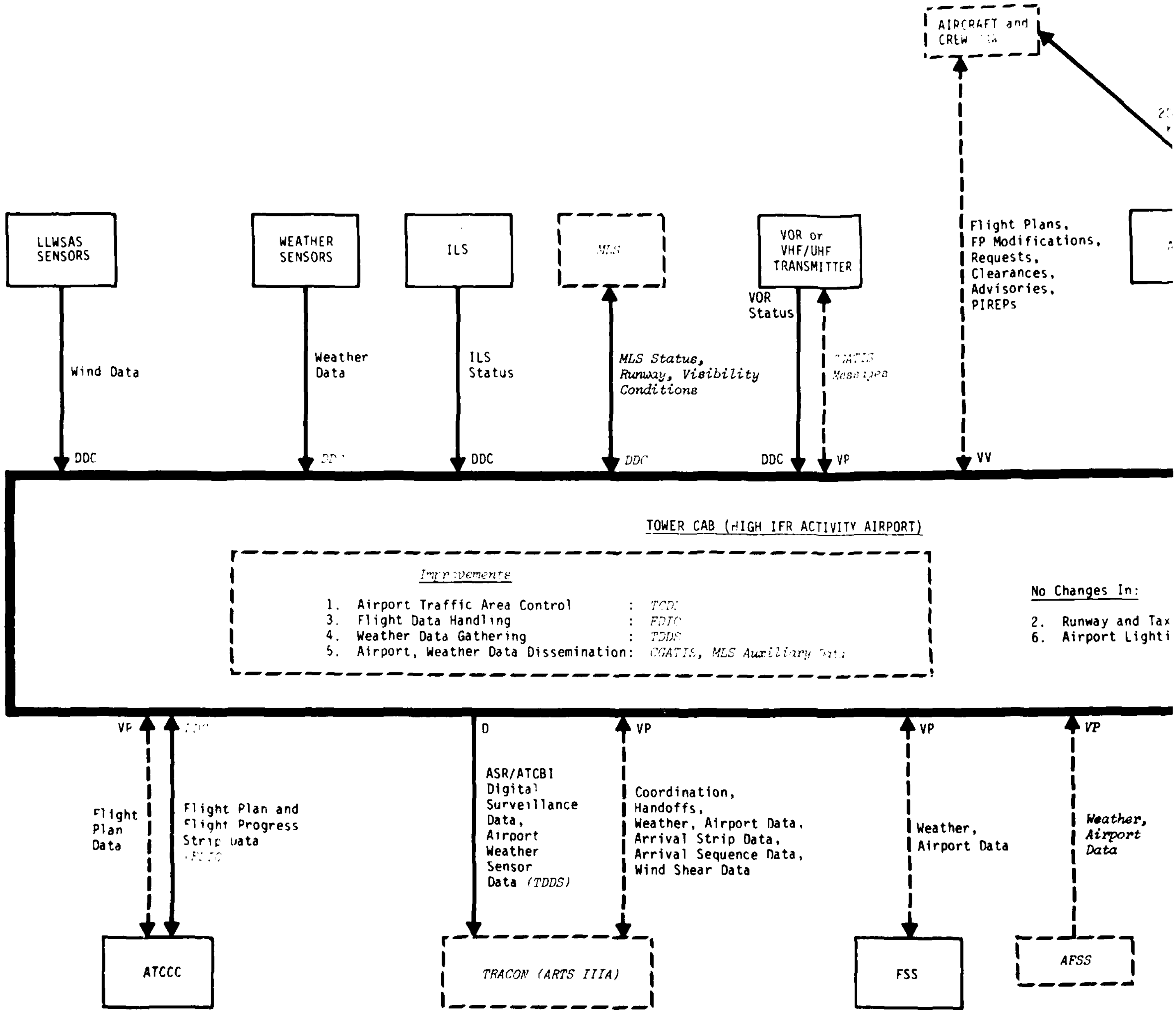
LEGEND

D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
V = Video Channel

VP = Voice Phone
VV = Voice, VHF or UHF Radio

FIGURE 4-4
CURRENT TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

2



NOTE: Changes from the Current System to the Near Term are indicated in *italics*.

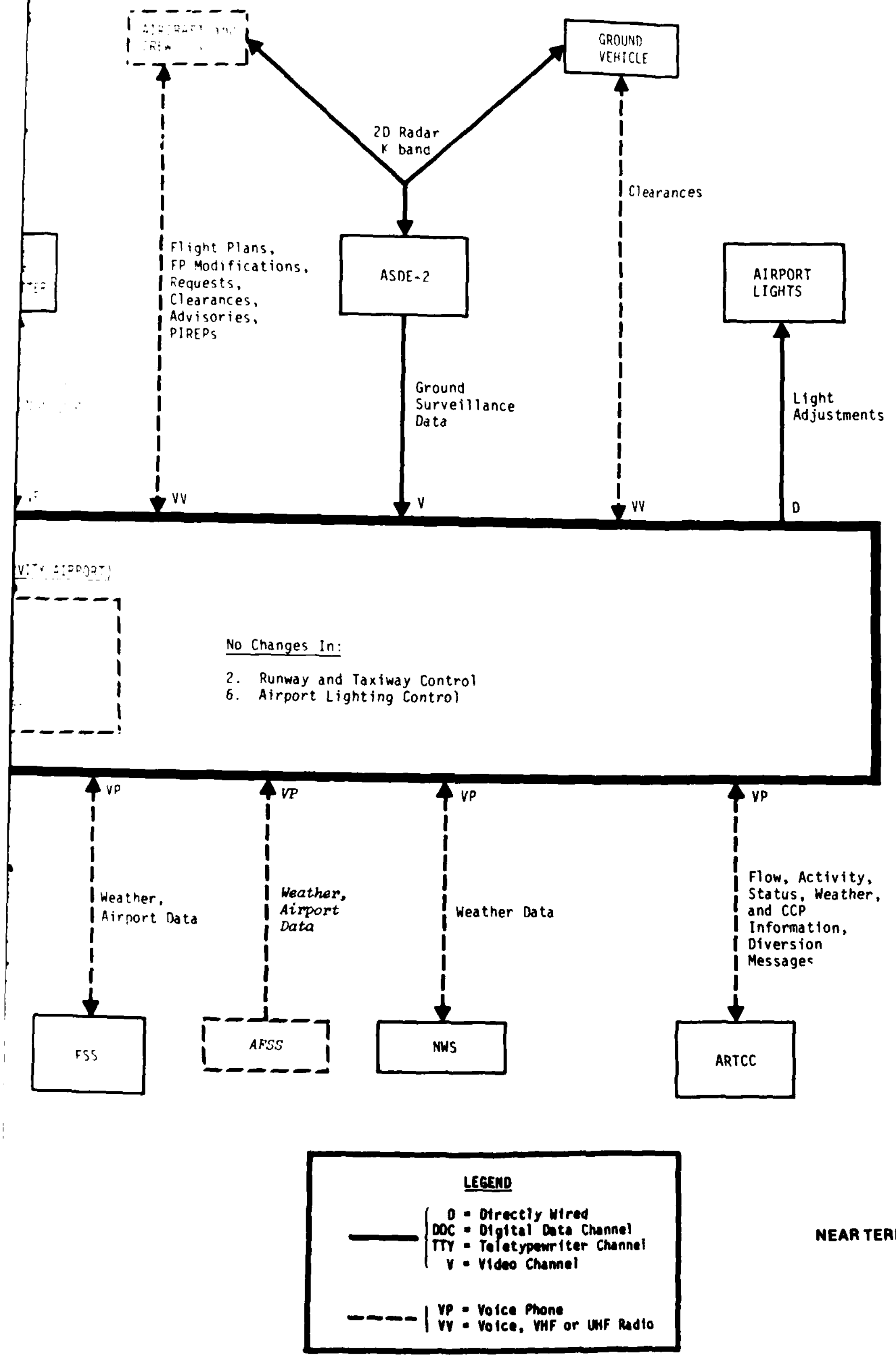
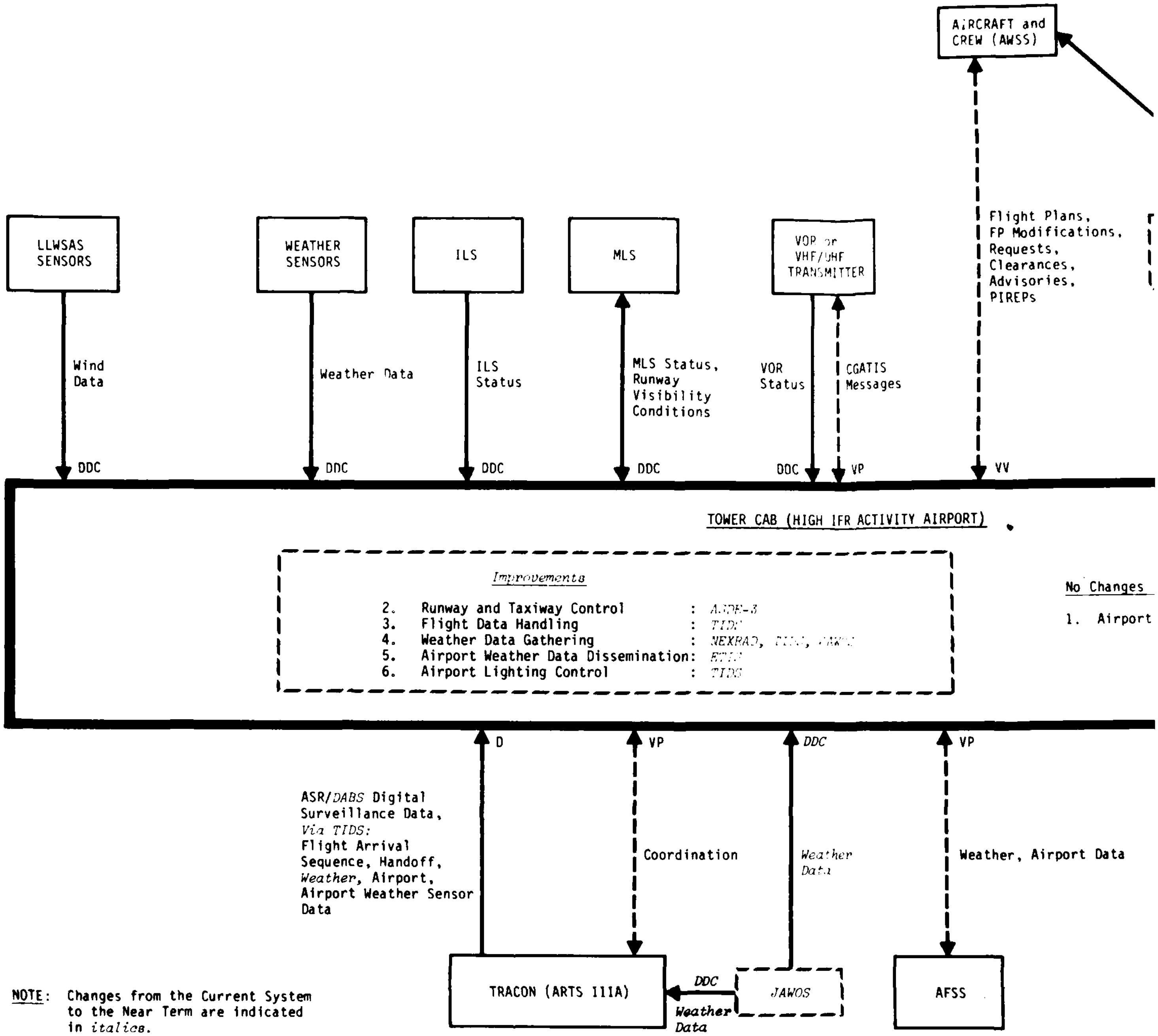


FIGURE 4-5
NEAR TERM TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

2



NOTE: Changes from the Current System to the Near Term are indicated in *italics*.

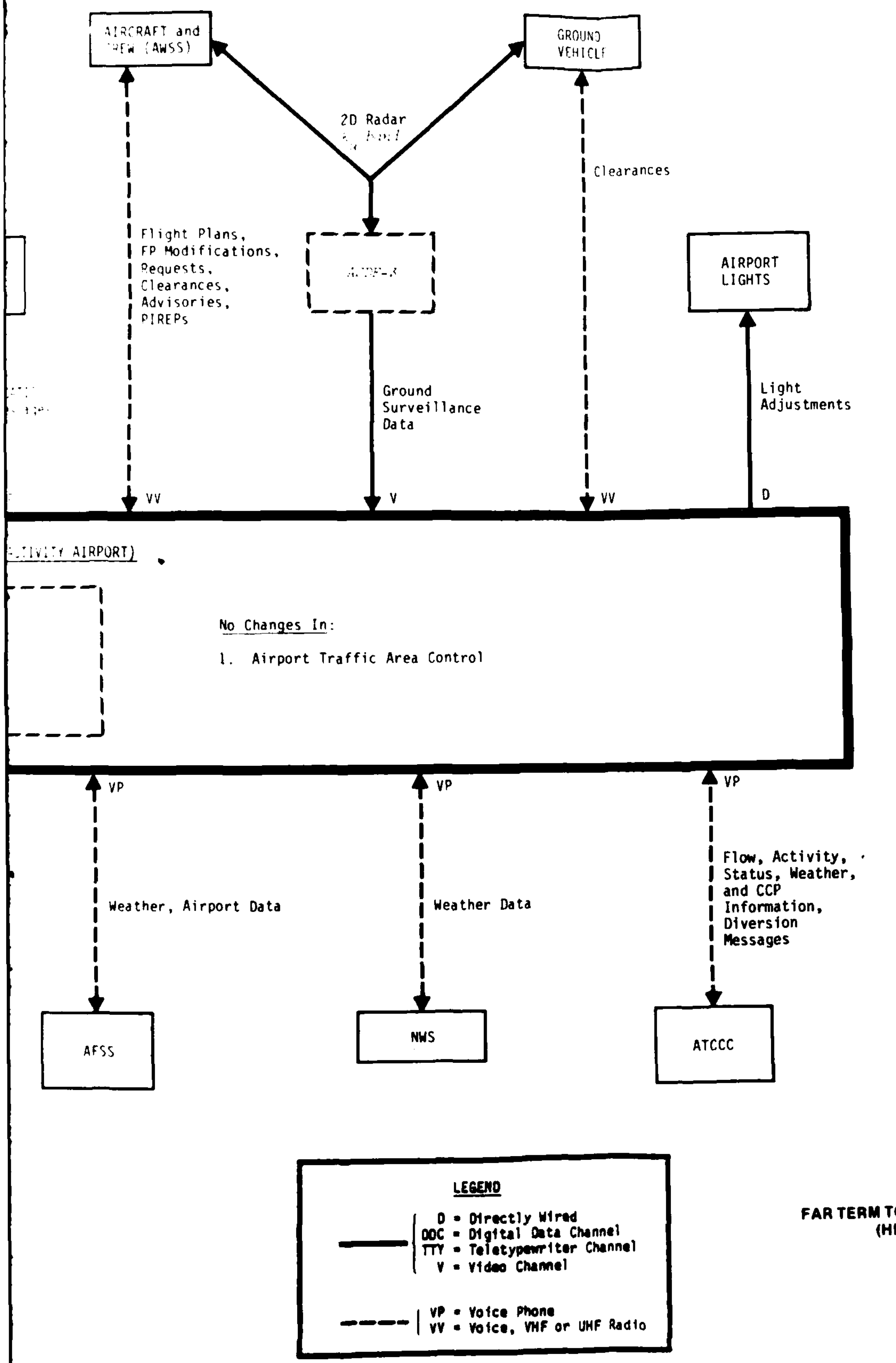


FIGURE 4-6
FAR TERM TOWER CAB CONNECTIVITY DIAGRAM
(HIGH IFR ACTIVITY AIRPORT)

connections between a Tower Cab and the other ATC facilities, and the changes in these connections due to the anticipated Near Term and Far Term improvements.

Two significant changes in connectivity will occur when the Near Term improvements are implemented.

- The installation of Microwave Landing Systems (MLSs) with an automatic landing capability at a few airports will require that the Tower Cab furnish the MLS with information on runway conditions and visibility. The MLS, in turn, will send this data along with MLS siting data and current MLS status data to the approaching aircraft via an MLS digital uplink (see Chapter 8 for a discussion of MLS).

- The installation of TCDDs at a few airports will mean that digital surveillance data instead of video data will be sent to the Tower Cab from the TRACON.

In the Far Term, three additional changes in connectivity may be made.

- The installation of NEXRADs would mean that weather radar data, including wind shear, would be sent to the Tower Cab and the TRACON.

- The replacement of FDIO with TIDS would mean that flight plan data would be exchanged with the ARTCC through the TRACON, rather than directly with the ARTCC. Other data, previously sent by voice between the Tower Cab and

the TRACON, would now be exchanged through TIDS.

- The installation of JAWOS systems at some airports would permit the automatic preparation of weather data for the transmission of ETIS messages via DABS. JAWOS would also send weather data to the tower to be used as an input to CGATIS.

4.3 Tower Cab Improvements Tentative Implementation Schedule

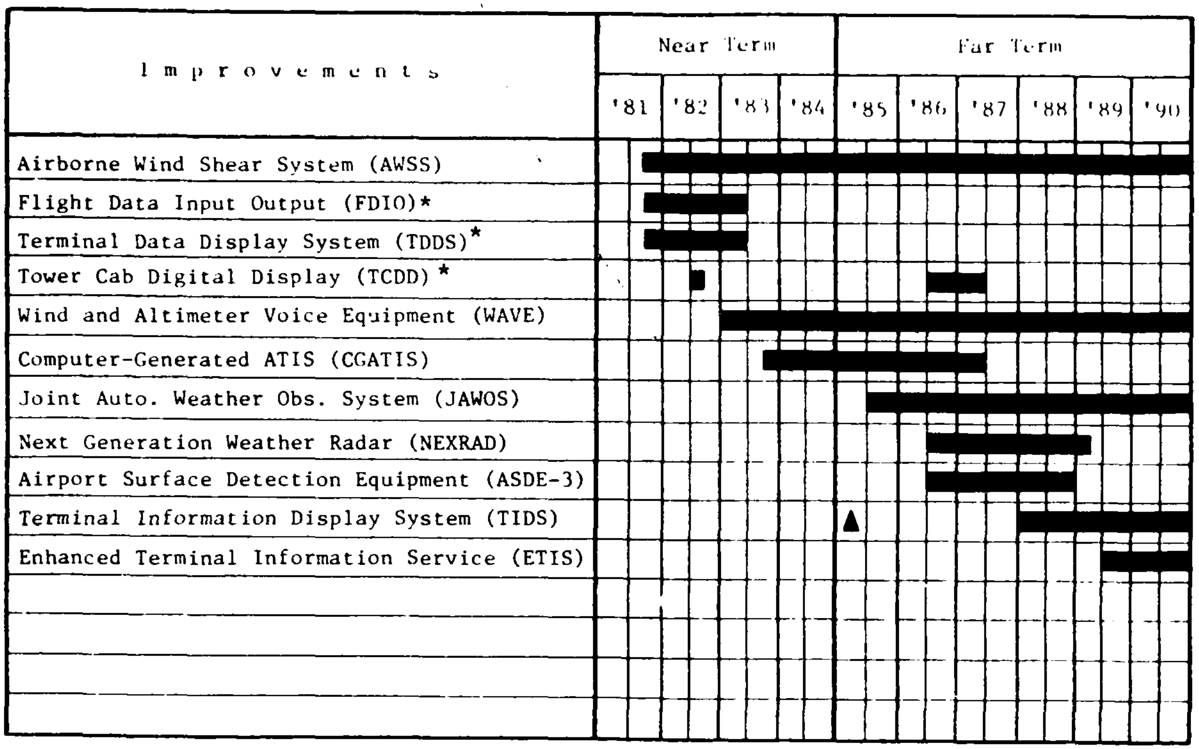
Figure 4-7 provides a tentative implementation schedule for the Tower Cab improvements discussed previously. It should be emphasized that this schedule may change in the future depending upon the operational need for and the development progress of the individual projects.

Information on the Near Term improvements was obtained from preliminary budgetary information for Fiscal Years 1981 to 1984, and information on the Far Term improvements was obtained from the FAA program managers involved with these projects.

4.4 Tower Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a Tower Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issue cited below was identified during the



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 4-7
TOWER FACILITIES
TENTATIVE IMPLEMENTATION SCHEDULE

preparation of this document and was reviewed with the appropriate FAA program managers. Follow-up on this issue was undertaken by a joint System Research and Development Service and Airway Facilities Service group. The issue and assumption stated below was consistent with the issue description still under consideration by this group in early December 1980. The reader is cautioned to check for recent changes in the status of the issue before forming any final conclusions.

The integration issue assumption pertinent to Tower Facilities is:

Issue 331: AVS - Terminal Sequencing and Spacing

It was assumed that the initial designs of the Terminal Sequencing and Spacing (TS&S) function will operate with fixed sets of longitudinal separation standards between aircraft on final approach. The Advanced Vortex System (AVS), a potential improvement, may be developed to permit variable separation standards to increase runway capacity while minimizing the likelihood of aircraft encountering wake vortices. It is assumed that TS&S may be modified to account for variable spacings if required.

5. AIR TRAFFIC CONTROL COMMAND CENTER

This chapter describes the system improvements planned for the Air Traffic Control Command Center and the interfaces with other ATC facilities for Current, Near Term, and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1.

The Air Traffic Control Command Center (ATCCC) described in this chapter contains five operational components operating under a center chief. The operational components and their locations are:

- o Central Flow Control Function (CFCF). The main control positions are in Room 626 of Federal Office Building 10A in Washington, D.C. Emergency Operating Facilities are in Atlanta, Georgia and Martinsburg, West Virginia. The Central Flow Control Computer Complex (CFCCC) is in the Butler Building at the Jacksonville ARTCC at Hilliard, Florida. An Automation/Communications center is located in the St. Luke's Professional Building in Jacksonville, Florida.

- o Airport Reservation Office (ARO). The office is located in the St. Luke's Professional Building in Jacksonville, Florida.

- o Central Altitude Reservation Function (CARF). The function is located in the St. Luke's Professional Building in Jacksonville, Florida.

- o Contingency Command Post (CCP). The main and backup posts are located respectively on the 10th and 6th floors of Federal Office Building 10A in Washington, D.C.

- o Central Flow Weather Service Unit (CFWSU). The CFWSU is co-located with the Central Flow Control Function in Room 626 of Federal Office Building 10A in Washington, D.C.

Voice communications and data communications used by the ATCCC are described in Chapter 9.

Except for the CFWSU, all of the operational components are manned by FAA employees. The CFWSU is manned by meteorologists assigned by the National Weather Service (NWS).

5.1 ATCCC Improvements

The future automation improvements within the ATCCC include new communications equipment, enhancements to CFCF through the addition of functional modules, the replacement of the dedicated store-and-forward CFCF communications with the general purpose National Airspace Data Interchange Network (NADIN), the automation of ARO, and the providing of an automated plotting system for CARF.

Table 5-1 summarizes the Near Term improvements and the Potential and Longer Range Improvements. Far Term improvements have not been defined. Most of the improvements that have been identified are in the CFCF. Therefore, Table 5-2 is provided to

TABLE 5-1
ATCCC FACILITY IMPROVEMENTS SUMMARY

Functions/Features	Current System (1980)	Near Term Improvements (1981-84)	Potential and Longer Range Improvements
1. Central Flow Control Function (CFCF) (see next table for details)	• Basic Central Flow Control Functions • Dedicated One-Way Store-and-Forward Communications from ARTCCs to CFCF	• Central Flow Control Enhancements* • Communications Processor with Dedicated Multi-point Circuits; Later, NADIN • Consolidation of Flow Control Programs into Delay Mangagement Program • Replacement of Store-and-Forward Network with NADIN	• Integrated Flow Management • AERA
2. Airport Reservation Office	• Manual	• Automated Capability*	• Integrated Flow Management • AERA
3. Central Altitude Reservation Function	• Manual	• Automated Plotting System*	• Integrated Flow Management • AERA
4. Contingency Command Post	• Manual	NC	
5. Central Flow Weather Service Unit (CFWSU)	• Provision of Current and Forecasted Weather Information and Weather Advisory Services to FAA. Automation Aid through Service 'A' System Data Processing Equipment at Washington ATCCC.	NC	• Service 'A' Systems at Emergency Operating Facilities (Atlanta and Martinsburg) • Automation of CFWSU

TABLE 5-2
CENTRAL FLOW CONTROL FUNCTION IMPROVEMENTS SUMMARY

Functions/Features	Current System (1980)	Near Term Improvements (1981-84)	Potential and Longer Range Improvements
1. Provide and Manage Data Base	• Some Domestic and International Flight Data Based on *Official* Airline Guide Supplemented by Inputs from ARTCCs and Operators	• Additional Domestic and International Flight Data • Traffic Load Analyses Available for En Route Fixes	• Integrated Flow Management • AERA (Automated En Route ATC)
2. Provide Simulations	• Processing of Data from Ten (Out of Seventeen) Pacing Airports	• Processing of Data from Additional Airports	
3. Provide Data Base Updates	• On-Line Domestic Departure and Diversion Messages for Flights to Seventeen Pacing Airports	• Addition of On-Line Domestic Progress Reports and Arrival Messages • International Departures, Progress Reports, and Arrival Messages	
4. Distribution of Central Flow Control Information	• Telephone • Data Flow From ATCCC via Facsimile to St. Luke's. Then, Keyboard Entry over Dedicated TTY Circuit to NATCOM. Then, NATCOM to ARTCCs via TTY Circuits.	• TTYs Replaced with DTEs* (Data Terminal Equipment) • More Direct and Rapid Data Flow among ATCCC, ARTCCs, Towers, FSSs, and Airline Dispatch Offices through Use of DTEs* and Data Communications Processor* • Data Communications Processor* at JAX • NADIN* • Message Edit Capability Prior to Output on Communications Network	
5. Obtaining Real-Time Flight Data	• Telephone • TTY (Center B Network) • Dedicated One-Way Store-and-Forward Communications from ARTCCs to CFCF	• Two-Way Communications Using DTEs* on Dedicated Multipoint Circuits. Later, NADIN* • On-Line General Information Message Exchanges • Replacement of Store-and-Forward Network with NADIN.*	• Integrated Flow Management • AERA

AD-A103 241 MITRE CORP MCLEAN VA F/G 1/2

FUTURE ATC SYSTEM DESCRIPTION ATC FACILITIES AND INTERFACES (19--ETC(U)

JAN 81 J H CHILDERS, R C HUNTER, D TUTTLE DOT-FA01-81-C-10001

UNCLASSIFIED MTR-81W6 FAA/RD-81/17 NL

3 OF 5

AD A103241

summarize these CFCF improvements.

Figures 5-1 and 5-2 describe the information flow for the ATCCC in the Current and Near Term time periods, respectively. The functions to be provided by the ATCCC are the same in both the Current and Near Term time periods. However, ARO and CARF will be automated, and the CFCF data base will be improved. These changes are shown in Figure 5-2. There will also be changes in communications. These are described in 5.1.1.2.

5.1.1 Central Flow Control Function

The Central Flow Control Function is the focal point for the management of nationwide air traffic flow. Through CFCF, remedial flow control procedures are put into effect to alleviate traffic flow problems. Frequently, such problems can be predicted by CFCF and remedial actions taken before the problems have fully developed.

CFCF improvements are expected to be made on an evolutionary basis -- making use of the experience gained in the operation of the simulation functions and in the manipulation of the data base. The improvements are envisioned to be in the expansion and modification of the CFCF data base, refinements in traffic loading analysis and simulations, improved reliability, introduction of graphics capabilities for CFCF specialists, and expanded communications capabilities.

5.1.1.1 Current System

Quota Flow and Fuel Advisory Departure (FAD) Procedures are the

INPUTS	ATCCC FUNCTIONS	OUTPUTS
From ARTCC • Situation Reports • Data Requests • Flight Plan for each non-air carrier flight • Departure Message for each flight (Domestic & International) • Remove Strip Messages for all proposed flights whose flight plans have been cancelled • Progress Reports (Domestic & International) • Arrival Messages (Domestic & International) • Diversion Messages (Domestic) From TRACON Tower Cab (High IFR Activity Airport) • Situation Reports • Data Requests From Airline Dispatch Office and Flight Service Facility • Situation Reports • Flight Movement • Coordination From OAG • Flight Plans for all domestic and international air carrier flights From Central Flow Controllers (Local Outputs) • Request for Data Count (6 message types) • Request for Data List (5 message types) • Request for Simulation (5 message types) • Data Base updates (6 messages)	1. Provide Central Flow Control Analyses	To ARTCC • Traffic Forecasts • Quota Flow Control Information • FAD Information • Requests for Situation Reports To TRACON/Tower Cab (High IFR Activity Airports) • FAD Information • Requests for Situation Reports • Predicted Delays for Arrivals and Departures • Quota Flow Control Information • Traffic Forecasts To Airline Dispatch Office and Flight Service Facility • Quota Flow Control Information • FAD Information • Traffic Forecasts • Coordination • Advisories To Military Base Operations Office • Coordination
From Airline Scheduling Committee • Air Carrier Reservations Allocations • Daily processed modifications to Air Carrier Reservations From Pilots (Air Taxi, General Aviation, and Military) or FSS • Request for Arrival or Departure Slot at a high density airport during high activity hours • Cancellation of Altitude Reservations	2. Automated Airport Reservations	To General Aviation and Military Pilots • Reservation Confirmation • Acknowledgement of Reservation Cancellation • Acknowledgement of Reservation Modifications
From Military Operations Headquarters • Request for Altitude Reservations to accommodate military exercises and VIP flights • Cancellation of Altitude Reservations	3. Provide Central Altitude Reservations with Automatic Plotting System at Jacksonville	To Military Operations Headquarters • Altitude Reservation Confirmation • Acknowledgement of Altitude Cancellation
From ARTCC, TRACON Tower, Air Carrier • Request for assistance in handling calamity or impending calamity	4. Provide Contingency Command Post	To Initiator via CCP Duty Officer • Policy Assistance and Advisories • Communications Monitoring
From National Weather Service • NOAA Satellite Pictures • National Weather Reports • Forecasts From NWS Radars • Radar Weather Display From NMSC • Weather Observations and Forecasts	5. Provide current and forecasted weather picture in addition to weather advisory services to FAA	To ATCCC Specialists • National Weather Reports • National Weather Forecasts • Detailed Weather Analysis for areas of interest

Underlined words = Changes from Near Term to Far Term version of system

FIGURE 5-1
CURRENT AIR TRAFFIC CONTROL COMMAND CENTER
INFORMATION FLOW DIAGRAM

INPUTS	ATCCC FUNCTIONS	OUTPUTS
From ARTCC • Flight Plan for each non-air-carrier flight that plans to land at a pacing airport • Departure Message for each domestic flight going to a pacing airport • Remove Strip Message for each proposed flight that intended to land at a pacing airport but has cancelled the flight plan • Situation Reports • Diversion Messages From TRACON • Situation Reports From Tower Cab (High IFR Activity Airport) • Situation Reports From OAG • Flight Plans for all domestic air carrier flights From Airline Dispatch Office and Flight Service Station • Flight Movement • Situation Reports • Coordination	1. Provide Central Flow Control Analyses	To ARTCC • Traffic Forecasts • Quota Flow Control Information • FAD Information • Requests for Situation Reports To TRACON • Requests for Situation Reports • Predicted Delays for Arrivals and Departures To Tower Cab (High IFR Activity Airport) • Requests for Situation Reports • Predicted Delays for Arrivals and Departures To Airline Dispatch Office and Flight Service Station • Coordination • Quota Flow Control Information • FAD Information • Traffic Forecasts • Advisories
From Airline Scheduling Committee • Air Carrier Reservation Allocations • Daily proposed modifications to Air Carrier Reservations From Pilots (Air Taxi, General Aviation, and Military) • Request for Arrival or Departure Slot at a high density airport during high activity hours • Cancellation of Slot Reservation	2. Provide Airport Reservations	To General Aviation and Military Pilots via ARO Personnel • Reservation Confirmation • Acknowledgement of Reservation Cancellation • Acknowledgement of Reservation Modifications
From Military Operations Headquarters • Request for Altitude Reservations to accommodate military exercises and VIP flights • Cancellation of Altitude Reservations	3. Provide Central Altitude Reservations	To Military Operations Headquarters • Altitude Reservation Confirmation • Acknowledgement of Altitude Reservation Cancellation
From ARTCC, TRACON/Tower, Air Carrier • Request for assistance in handling calamity or impending calamity	4. Provide Contingency Command Post	To Initiator via CCP Duty Officer • Policy Assistance and Advisories • Communications Monitoring
From National Weather Service • NOAA Satellite Pictures • National Weather Reports • Forecasts From Remote Weather Radars • Weather Maps From WMSC • Weather Observations and Forecasts	5. Provide current and forecasted weather picture in addition to weather advisory services to FAA	To ATCCC Specialists • National Weather Reports • National Weather Forecasts • Detailed Weather Analysis for areas of interest

FIGURE 5-2
NEAR TERM AIR TRAFFIC CONTROL COMMAND CENTER
INFORMATION FLOW DIAGRAM

principal techniques by which the Central Flow Control Function solves traffic flow problems resulting from terminals being impacted. A terminal is impacted if it and its associated holding stacks are unable to accept aircraft at the rate at which they are arriving for landing. The cause of such a condition is almost always decreased terminal capacity rather than unusually high demand. Decreases in terminal capacity are caused primarily by bad weather conditions, equipment outages, or unavailabilities of runways. The ARTCC containing an impacted terminal will use its holding capacity to absorb as much of the excess amount of landing traffic as is possible. However, a condition is often reached in which the current or predicted demand exceeds that ARTCC's reasonable capacity, and the ARTCC itself becomes impacted. it is under such circumstances that Quota flow is put into effect.

Under Quota Flow, each of the adjacent ARTCCs is given a quota for the rate (number of flights per hour) at which it can send flights (bound for the impacted terminal) into the impacted ARTCC. Such an adjacent, non-impacted center may have a demand for the impacted terminal that is in excess of the assigned quota. If so, the non-impacted center will attempt to absorb the difference between demand and quota by holding or delaying flights within its airspace.

Sometimes a non-impacted center's holding capacity becomes saturated or is in danger of becoming saturated. Under those circumstances, a "second tier" center has a Quota Flow quota applied to it. First tier centers are centers that are feeding air traffic to an impacted ARTCC. A "second tier" center is one that is feeding air traffic to a "first tier" center. As with

first tier centers, a second tier center may have a demand for the impacted terminal that is in excess of the assigned quota. If so, the second tier center will absorb the difference between demand and quota by holding or delaying flights within its airspace.

The FAD Procedures were developed to conserve fuel while solving traffic flow problems resulting from terminals being impacted. The FAD system accomplishes this by having aircraft absorb required delays on the ground rather than in the air. The system was originally implemented for O'Hare Airport in 1976. It now serves several other major airports. The FAD Procedures are instituted at an airport when the CFCF forecasts that the delays at the airport will exceed 30 minutes for an extended period of time. The CFCF then calculates expected delays for arrivals within specific future time brackets. Airline dispatchers are instructed to have their aircraft absorb all but the last 30 minutes of such delays on the ground. The ground delay time incurred by a FAD aircraft is then treated as the equivalent of the same delay time in the air. After their departure, FAD aircraft are given clearances that should limit their airborne delay to less than 30 minutes.

The flow control specialists at the ATCCC have automation support available that can predict flow control problems at any of the ten (as of December 1980) pacing airports whose data is currently processed by CFCF. (A pacing airport is one whose traffic load is great enough as to regularly cause delays for some of the arriving and departing aicraft. There were 17 pacing airports as of December 1980.) Figure 5-3 describes the current communications capability.

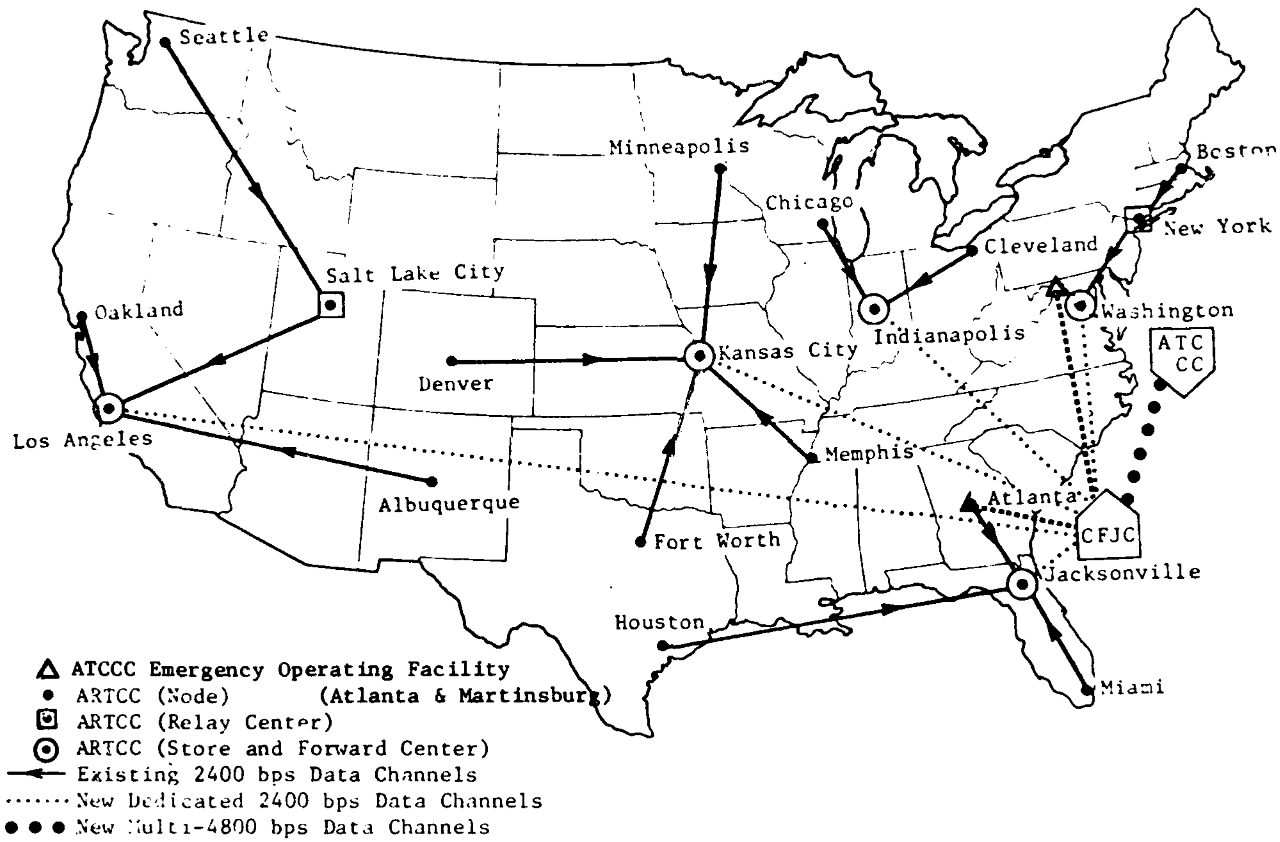


FIGURE 5-3
CURRENT CENTRAL FLOW CONTROL COMMUNICATIONS NETWORK

CFCF specialists forecast air traffic activity and predict flow control problems through their analysis of information they receive from:

- The 20 CONUS ARTCCs (verbal information from Local Flow Controllers)

- Control towers (high-activity terminals) (verbal information from controllers)

- The airline dispatch offices

- CFWSU personnel in the ATCCC

- The Central Flow Control Computer Complex

  - CFCF Data Base consisting of Official Airline Guide (OAG) Data, Flight Plan and other information entered by ATCCC personnel, and real-time data on flight progress from the en route (ARTCC) computers

  - Traffic activity forecasts calculated from the CFCF Data and other information

The real-time digital data from the en route computers consists of flight plan, flight plan change, domestic departure, and domestic diversion messages. As can be seen in Figure 5-3, the messages are sent through a dedicated network in which five of the ARTCCs act as store-and-forward facilities for the remaining ARTCCs. This network is limited to one-way communications from ARTCCs to the CFCCC. No message acknowledgements or other

normal communications protocol capabilities are provided.

CFCF has seven primary positions and one weather support position, each directly connected by telephone to the 20 CONUS ARTCCs and the control towers in high-activity terminals. The operating positions are provided with inputs from the previously mentioned sources. The verbal information from ARTCCs includes situation reports collected several times a day from each ARTCC. These reports include current and expected personnel staffing, local weather conditions, equipment status, radio frequencies, and local assessments of real and potential problem areas. Most of this information is collected by telephone utilizing a direct push-button callup and conferencing capability that connects directly to all of the ARTCCs and to control towers in high-activity terminals. In addition, Autovon circuits and the Federal Telecommunications System (FTS) are available to communicate with the ARTCCs. The same capability exists with all the major Air Traffic Control Towers.

CFCF personnel communicate with the CFCCC through DTEs (Data Terminal Equipment) at the ATCCC. They can enter messages (data base updates, requests for forecasts, etc.) via the DTE keyboards. On request, the CFCCC (Hilliard) prepares forecasts of air traffic activity based on the information in the data base and sends these forecasts to a DTE or the medium speed printer at the ATCCC. The forecasts are then analyzed by the Central Flow Control Specialists. If warranted, the specialists prepare flow control advisory messages (traffic forecasts, traffic quotas, and FAD information) and send them to the ATCCC St. Luke's facility via facsimile equipment. Then, St. Luke's personnel copy the information via keyboard and send it to

NATCOM (Kansas City) via a dedicated TTY circuit. NATCOM disseminates the information to the appropriate ARTCCs, FSSs, and airline dispatch offices.

5.1.1.2 Near Term Improvements

In the Near Term, it is expected that all of the flow control programs (e.g., Quota Flow, FAD) will be consolidated into a single Delay Management Program. The CFCF data base will be expanded and improved. This should result in substantial improvement of the predicting capability. It should allow all significant flow control problems to be recognized early enough to enable flow adjustments to be made to eliminate the problems, or to minimize their effects on the national flow control picture, and it should generally allow traffic flow to be managed with greater precision than is possible today.

It is expected that early in the Near Term, the Interim Automated Flow Control System (IAFCS) will be implemented. Its primary purpose is to provide additional improved data communications capabilities that will improve the interfaces among various elements of the CFCF and will facilitate the exchange of traffic forecasts, Quota Flow control information, FAD information, system status reports, and data requests. Each ARTCC and each of the 17 pacing airports will be connected through dedicated multi-point circuits to a new IAFCS data communications processor at St. Luke's. Similar connections will be available between the data communications processor and the CFCCC, the Washington ATCCC, the two Emergency Operating Facilities (Atlanta and Martinsburg), Flight Service Stations, and Airline Dispatch Offices. Each of these access points will

be equipped with one or more DTEs (Data Terminal Equipment).

Later in the Near Term, it is expected that all interfacility communications involving the ATCCC will be accomplished through NADIN. The one-way, five-ARTCC, store-and-forward data communication network will be replaced by NADIN connections with full communications protocol capabilities. The integration of ATCCC digital communications into NADIN would provide for the expansion of CFCF data collection and for the broader dissemination of Central Flow Control and other ATCCC reports or decisions.

Near Term CFCF software improvements are expected to include:

- output message edit capability where review of output messages may be accomplished at the ATCCC and changes made, if necessary, prior to output on the communications network;

- CFCF output messages directed onto the data communications network from either the ATCCC or CFCCC based upon an operator request or program control;

- General Information message input using the available communications network;

- the ability to accept and process additional inputs from en route and/or terminal facilities (e.g., domestic and international progress reports, arrival messages, and international departure messages); and

o traffic load predictions for en route fixes.

5.1.1.3 Potential and Longer Range Improvements

Hourly Summary Data

A potential improvement that is under consideration, is having the CFCCC provide hourly summaries of data to CFCF personnel in the active ATCCC. The summaries would include each airport's predicted arrivals and departures, simulated delay prediction reports, and flow control reports that are used in the Quota Flow and Fuel Advisory Departure (FAD) flow control procedures.

AERA

AERA is a longer range, potential improvement that would probably affect the CFCF, ARO, and CARF. AERA would solve routine spacing and sequencing problems and implement the solutions through automatically-generated messages sent to pilots via Data Link or voice radio. Among other functions, AERA would significantly aid or replace the Local Flow Control function (see 2.1.7) in ARTCCs and would include the capabilities of En Route Metering (see 2.1.7). See 2.1.3.4 for further information on AERA.

Integrated Flow Management

Preliminary work is underway on an Integrated Flow Management (IFM) concept that would affect the CFCF, ARO, and CARF functions. IFM is a planning process that would provide for communications and coordination among the various ATC facilities

(Central Flow Control, En Route, TRACON, Tower Cab) to assure the efficient utilization of existing resources to meet the demand imposed on the ATC system. When expected congestion warrants, IFM would develop a coordinated and efficient systemwide operational plan that would be executed through control of individual aircraft by the ARTCC and TRACONs. The IFM process addresses the problem areas of flow planning related to the volume of traffic, expected and unexpected constraints, contingency plans, system efficiency, and stability under predicted operating conditions.

5.1.2 Central Flow Weather Service Unit

The CFWSU is similar to the Center Weather Service Units at ARTCCs. CFWSU personnel furnish air traffic personnel at the CFCF with weather data and interpretations of that weather data in the following forms:

- o analyses of existing surface weather,
- o the upper-air situation,
- o the orientation of the jet stream,
- o identification of areas associated with clear-air turbulence, and
- o forecasts of terminal conditions.

Meteorologists are assigned to the CWFSU by the National Weather Service. They assemble and correlate weather data from many sources:

- Weather charts of the upper-air conditions (including winds and precipitation) are received from the National Meteorological Center on an NWS facsimile circuit. Some of these charts are transferred to transparencies and are displayed on the wall-sized screens by the rear-screen projectors.

- Weather observations and forecasts are received from the Weather Message Switching Center (WMSC). The information is fed directly into an FAA-FSS Service "A" System where it is stored on disks. The latest applicable information is retained for use by ATCCC specialists. Through Service "A" System consoles, they can request information of interest and can have it displayed on a console CRT or printed on a Service "A" System printer.

- Facsimile reproductions of radar displays from 37 (as of December 1980) NWS Weather Radars and ARSRs (Air Route Surveillance Radar) are provided over dial-up telephone circuits.

- The National Oceanic and Atmospheric Administration's (NOAA's) National Environmental Satellite Service transmits satellite picture data over data lines to the ATCCC. The pictures are obtained from the Geostationary Operational Environmental Satellite (GOES). They show

short-term development and movement of cloud systems over the 48 contiguous United States at 30-minute intervals.

5.1.3 Airport Reservation Office

The Airport Reservation Office (ARO) is designed to relieve congestion at the country's four highest activity airports (La Guardia, John F. Kennedy, Washington National, and O'Hare). During high activity hours, arrivals and departures at these airports may be restricted to aircraft for which prior reservations have been made with ARO. Under these circumstances, most of the airport time slots are allocated to commercial air carriers based upon the published schedules. (Special, current-day modifications to the schedules can be requested by the Airline Scheduling Committee. The ARO coordinates these changes with the affected airports and makes adjustments where necessary.) Air taxis receive the second allocation of time slots. These are also based on schedules. General aviation and military users receive any remaining time slots.

After determining the air carrier and air taxi reservation allocation, the ARO allocates the remaining slots to pilots who request slots directly from the ATCCC. A confirmation or denial of the requested slot is made to the pilot, or an alternate time is provided.

In the Near Term, the ARO function will be automated through the use of the CFCF data base. This will allow reservations to be entered through an ARO operator's keyboard for those flights

expected to arrive at one of the four reservation-controlled terminals when a slot time is available. Monitoring of available slots within the CFCF data base will be possible through the CFCF arrival list routine. This list will include all previously reserved air carrier flights, as well as any supplementary air carrier flights, general aviation, and military flights which have been granted reservations by the ARO operator.

5.1.4 Central Altitude Reservation Function

The Central Altitude Reservation Function (CARF) has the authority to reserve certain defined airspace for specific temporary use. Generally, this use is for the mass movement of military aircraft that are being flown with less separation than is normally allowed. Other uses include air refueling operations, rocket firings, missile firings, training flights for low-level navigation and bombing, and VIP flights that require airspace protection. CARF has primary jurisdiction over high altitude airspace (above 18000 or 24000 feet) within CONUS, Alaska, Hawaii, and U.S. Oceanic Flight Information Regions. CARF also has jurisdiction over the airspace required for special low altitude military training routes referred to as Olive Branch routes. CARF aircraft may create unsafe conditions for civil aircraft within normal controlled airspace due to the manner in which the CARF aircraft fly or the fact that CARF flights may consist of two or more aircraft. CARF provides a three-dimensional, protective, airspace envelope around the planned route of flight for a specified time period. CARF accomplishes this by instructing the appropriate ARTCCs and TRACONs to deny non-CARF clearances to the envelope airspace.

The size of envelope is determined by the type of mission.

Generally, CARF receives the requests for protected airspace from cognizant military organizations well in advance of the proposed event. This allows CARF to have adequate time for notification and coordination between the impacted facilities (e.g., ARTCCs, Terminals, Military Operations, etc.). CARF also serves as the United States coordination agency for processing airspace reservation requests for flights that will traverse foreign airspace.

An automatic plotting system will be provided to the CARF during the Near Term. The CARF plotting function will be provided through the use of the cathode ray tube graphics capabilities of a dedicated computer that will be installed in the St. Luke's Building in Jacksonville. Plots will be presented to the CARF operation that compare routes, altitudes, and areas of high traffic activity against all other CARF requests previously entered into the system to assure that no conflicts will result from any CARF assignments.

5.1.5 Contingency Command Post

The Contingency Command Post (CCP) is designed to become activated when a major calamity (such as a catastrophic failure at one of the ARTCCs) occurs within the air traffic control system. Under such circumstances, the CCP would arrange, to as large an extent as possible, for ATC coverage of the airspace normally controlled by the failed center. The CCP would accomplish this through coordination with controllers at each of the adjacent ARTCCs and appropriate TRACONs/TRACABs.

The operational aid provided in support of the Contingency Command Post (CCP) is in the form of direct access telephone channels to each ARTCC (20) and to each control tower at high-activity terminals. Additionally, limited dialing capability is provided for conferencing up to 40 locations on one call. Rear-screen projectors that utilize automated slide selection are also provided to view a CONUS weather map, ARTCC maps with or without route structures and/or weather, terminal diagrams, terminal forecasts, etc. The communications channels available to the Contingency Command Post are also available for use by the other functions within the ATCCC.

Requests for assistance in handling impending crises are made to the Contingency Command Post (CCP) where policy assistance and advisories are provided together with communications monitoring until the problem is resolved or the cognizant field facility can handle the problem.

5.2 ATCCC System Connectivity

Figures 5-4 and 5-5 show the interfacility connectivity for the Current and Near Term ATCCC, respectively. The changes noted on Figure 5-5 result from the CFCF functional additions and the replacement of the previous communications capability with NADIN. The Interim Automated Flow Control System (see 5.1.1.2) is not shown, since it is assumed that it will be replaced (except for the buffering available in the IAFCS communications processor) by NADIN.

The Near Term functional changes include: the addition of domestic Progress Report and Arrival messages and the addition

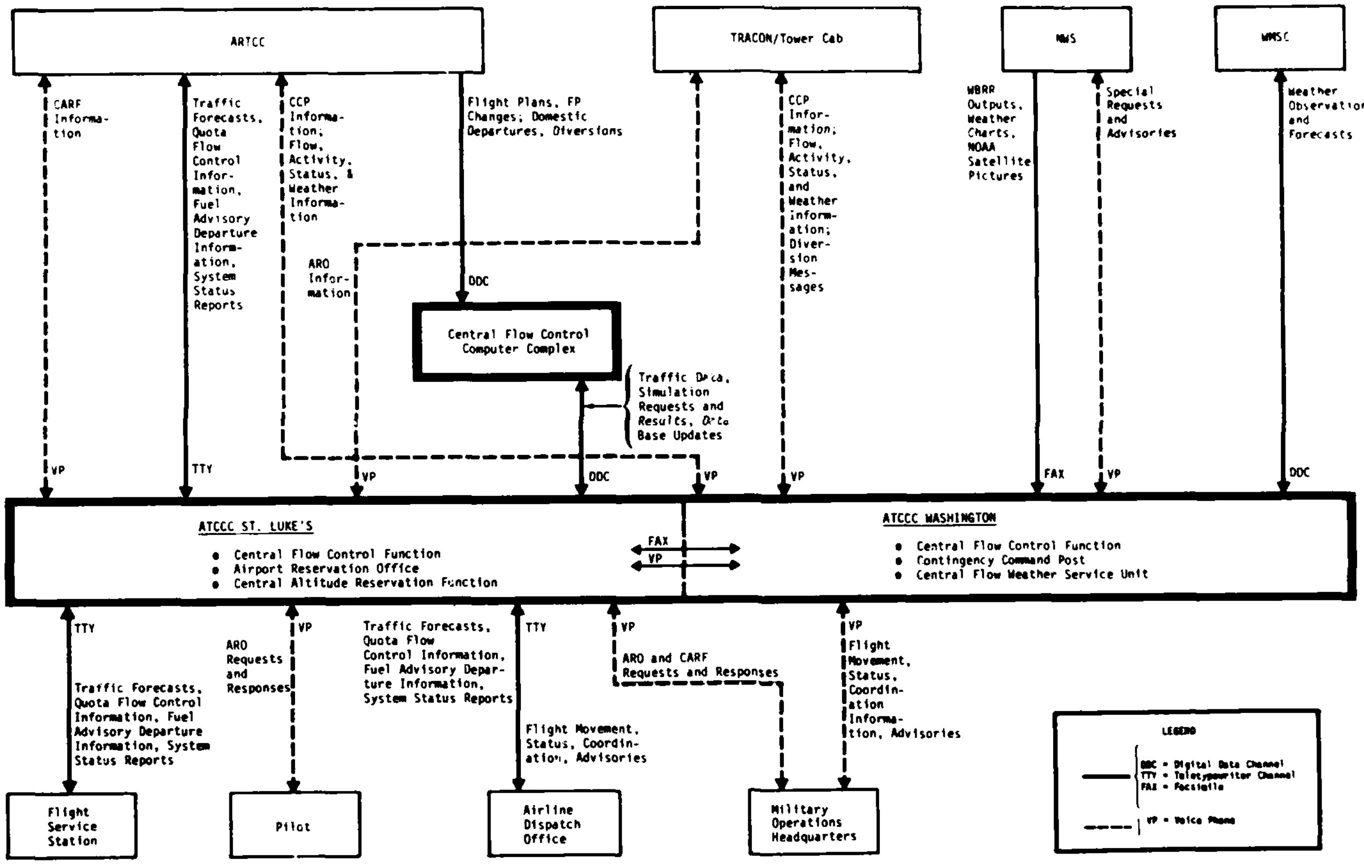
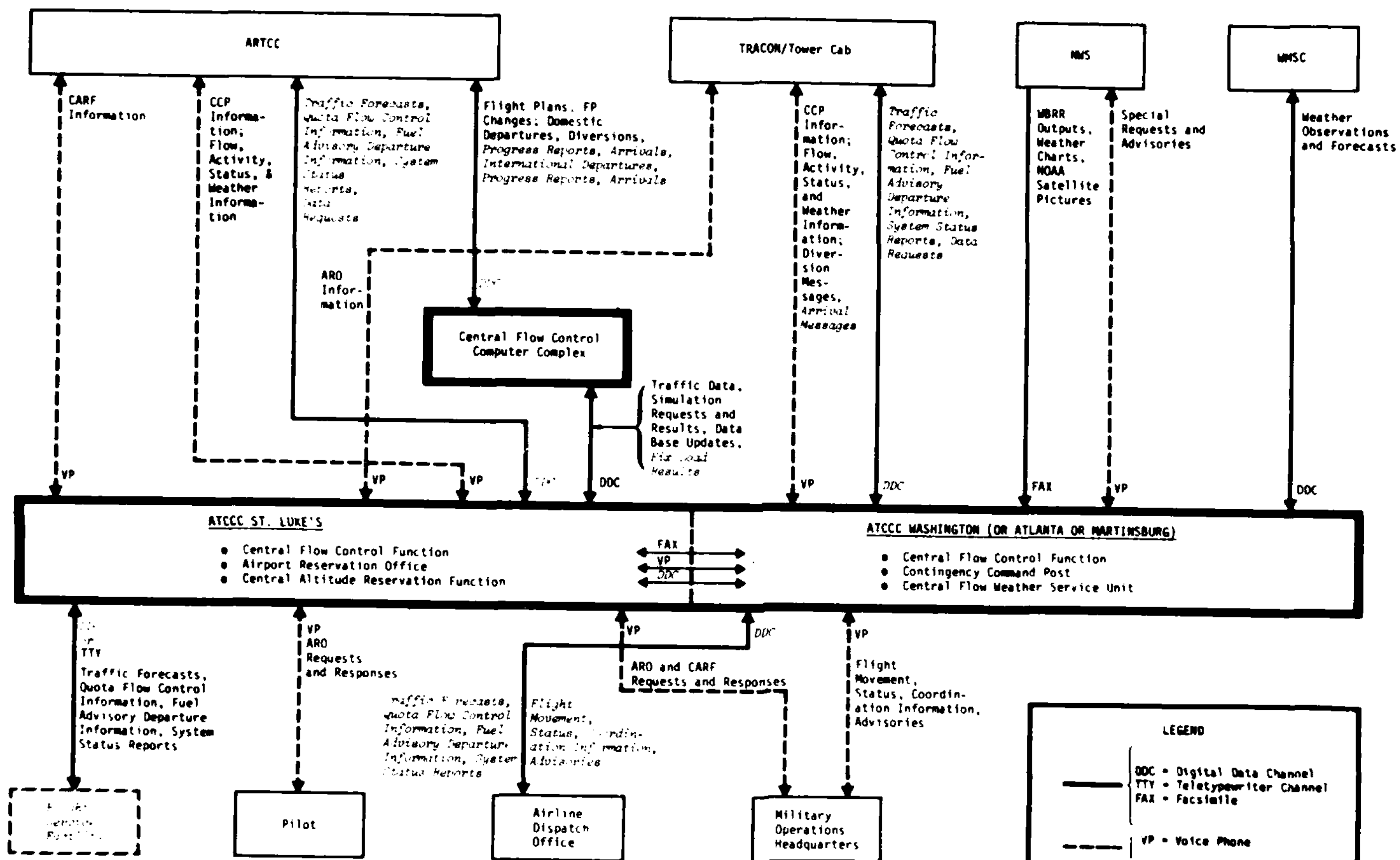


FIGURE 5-4
CURRENT ATCCC CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 5-5
NEAR TERM ATCCC CONNECTIVITY DIAGRAM

of international Departure, Progress Report, and Arrival messages to the message repertoire between the ARTCCs and CFCCC; the additional requests (and results) that can be obtained from the enhanced data base (fix loading results, etc.) and hardware (e.g., DTEs, communications processor) changes. Far Term improvements for the ATCCC have not yet been defined.

5.3 ATCCC Tentative Implementation Schedule

In the Near Term, an automated plotting system will be added to CARF, and ARO will be automated through the use of the CFCF data base. As shown in Figure 5-6, no specific times have been established for adding the enhanced CFCF functions during the Near Term. It is expected that enhancements to the CFCF function will be determined as experience is gained on the present system or as needs are identified. Figure 5-6 identifies the addition of the automatic plotting system for CARF.

5.4 ATCCC Facility Interface Planning Summary

In the preparation of this chapter, it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at the ATCCC Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issue cited below was identified during the preparation of this document and was reviewed with the appropriate FAA program managers. Follow-up on this issue was

Improvements	Near Term				Far Term					
	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90
Central Flow Control Enhancements*										
Automated Plotting System for CARF*										
ARO Automation*										
Data Communications Processor*										
Nationwide Deployment of DTEs*										

Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

FIGURE 5-6
ATCCC FACILITY TENTATIVE IMPLEMENTATION SCHEDULE

undertaken by a joint System Research and Development Service and Airway Facilities Service group. The issue and assumption stated below was consistent with the issue descriptions still under consideration by this group in December 1980. The reader is cautioned to check for recent changes in the status of this issue before forming any final conclusions.

The integration issue assumption pertinent to the ATCCC Facility is:

Issue 405: Traffic Flow Management

It was assumed that the various advanced systems and automation improvements (e.g., En Route Metering, Terminal Sequencing and Spacing, and Central Flow Control) that are planned for traffic flow management will be implemented as compatible packages.

6. FLIGHT SERVICE FACILITIES

This chapter describes the system improvements planned for the Flight Service Facilities and the interfaces with other ATC facilities for Current, Near Terms and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1. Those facilities which support the provision of preflight and inflight services primarily to non-air carrier pilots and air crews are described. Preflight briefings provide the latest information regarding current and forecast weather, general flying conditions and the status of airspace and navigational facilities along the planned route of flight. Either Visual Flight Rule (VFR) flight plans or Instrument Flight Rule (IFR) flight plans may be filed. Inflight services include the provision of updated weather information, traffic control information to aircraft unable to contact an ARTCC, flight assistance to lost or disoriented pilots, flight following of VFR aircraft in hazardous areas and coordination of search and rescue operations. Communications, weather radar, and navigational aids are not included except to show interfaces to the primary facilities.

During the Current time period, the primary facility described is the non-automated Flight Service Station (FSS). Figure 6-1 shows United States Locations for non-automated Flight Service Stations. For the Near Term, Model 1 of the Flight Service System automation program provides the initial capability. (See Figure 6-2). With Model 1, Flight Service Data Processing Systems (FSDPS) will be providing centralized computer support to 41 Automated Flight Service Stations (AFSS) while the non-automated Flight Service Station continues to function in

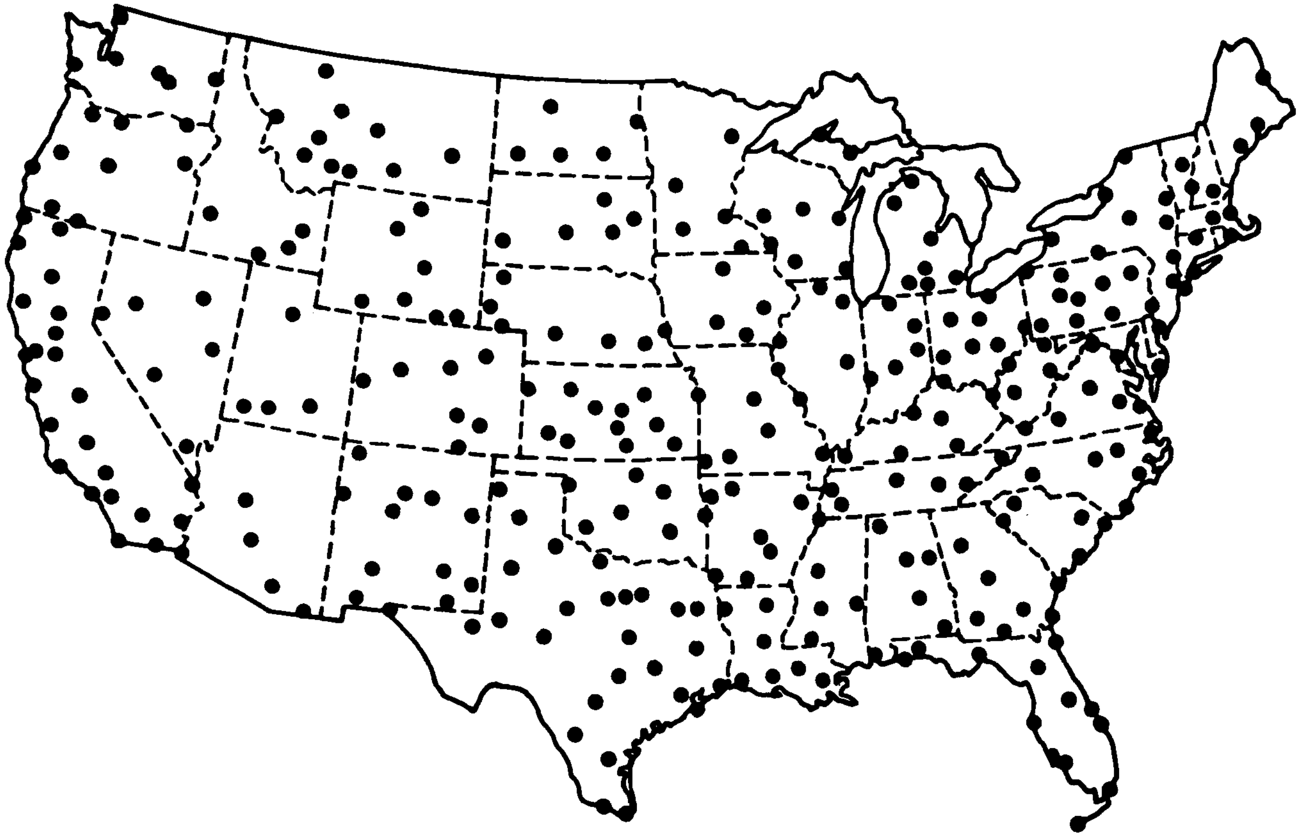


FIGURE 6-1
NON-AUTOMATED FSS LOCATIONS

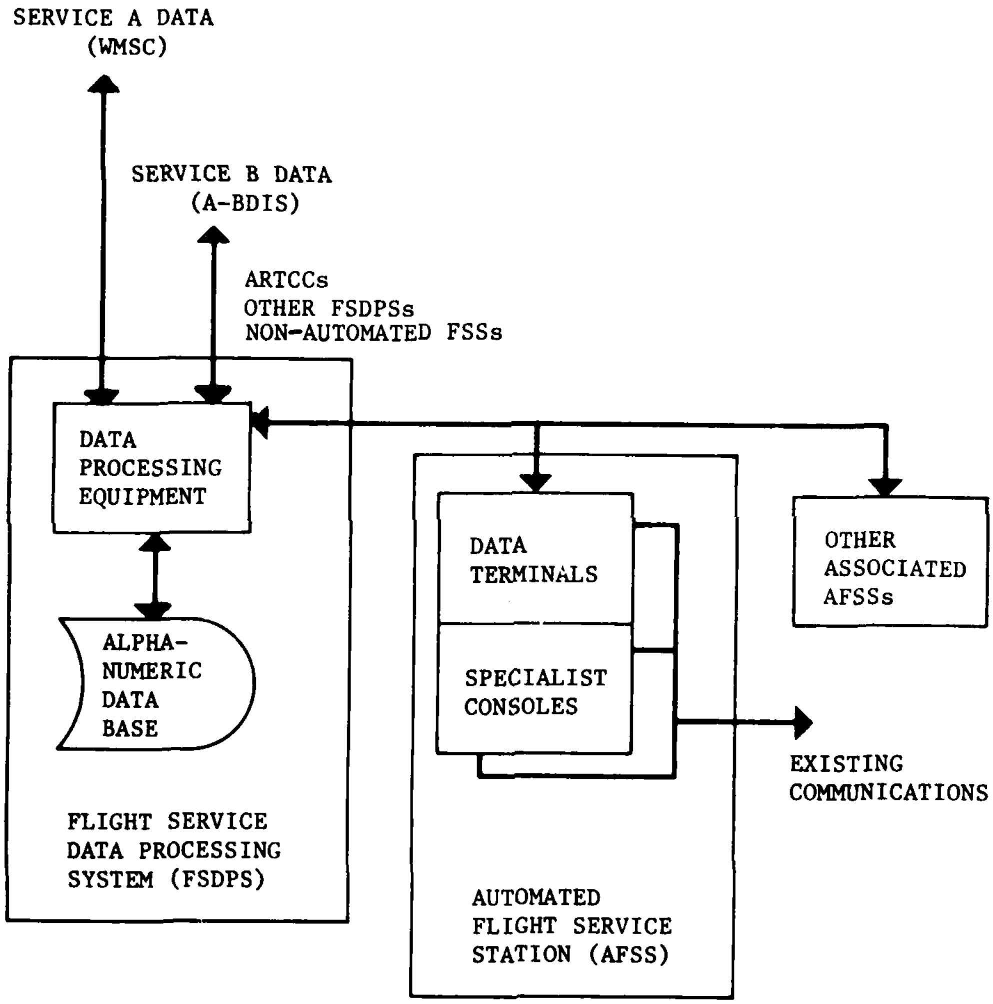


FIGURE 6-2
MODEL 1 FLIGHT SERVICE AUTOMATION

the remaining locations. Figure 6-3 shows the locations of Flight Service Facilities and highlights Model 1 automated facilities. Model 1 will provide automated support to the specialist both for the entry and retrieval of information and for automated data base maintenance. Some 14 FSDPSs will be installed at ARTCC locations and will support the 41 of AFSSs located at existing FSS sites. FSDPS hardware for Model 1 is to be a subset of the Model 2 computer hardware. Model 2 AFSSs will contain a new improved display system. Automated prototype systems currently in place, namely the Aviation Weather and NOTAM System (AWANS) (Atlanta, Georgia and Indianapolis, Indiana) and the Meteorological and Aeronautical Presentation System (MAPS) (Washington, D.C.), will not be replaced until Model 2 is implemented. The Public Voice Response System (VRS) now available in an experimental version, may lead to an Interim VRS capability in the near term.

Later in the Near Term, with the implementation of Model 2, automation of specialist support is extended by the provision of more extensive and more selective retrieval capabilities, improved graphics and improved displays. Direct support to the pilot provides for access to the system utlizing the Direct User Access Terminal (DUAT). For Model 2, the computer hardware is expected to be expanded over Model 1, communications capabilities will be enhanced, specialist consoles will be replaced and direct preflight and post flight support to the pilot and air crews is planned to be available from the system (See Figure 6-4). Additional FSDPSs will be installed for Model 2 at the remaining 6 ARTCC locations. The number of AFSSs will increase to 56. Two Aviation Weather Processors (AWPs) will be supplying centralized data base maintenance for weather and

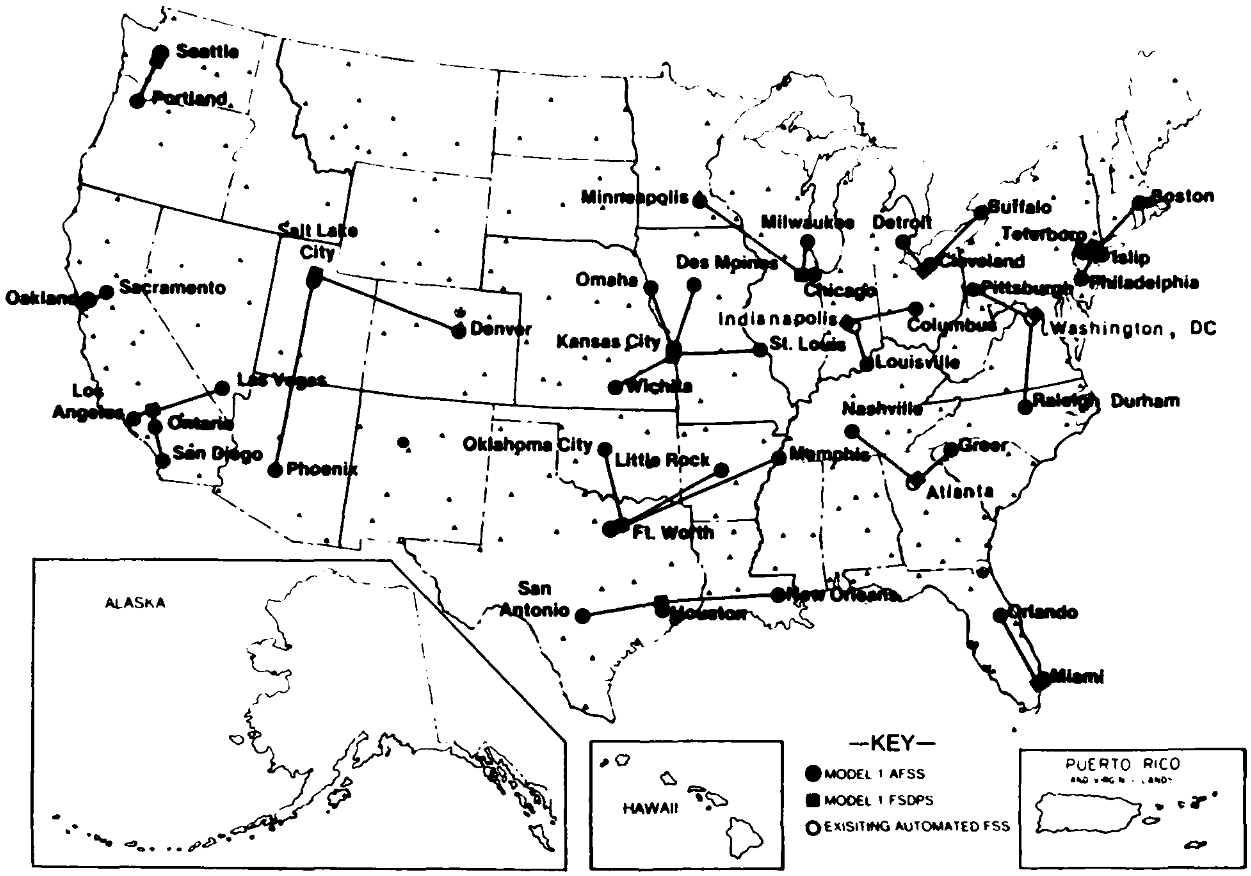


FIGURE 6-3
MODEL 1 FACILITY LOCATIONS

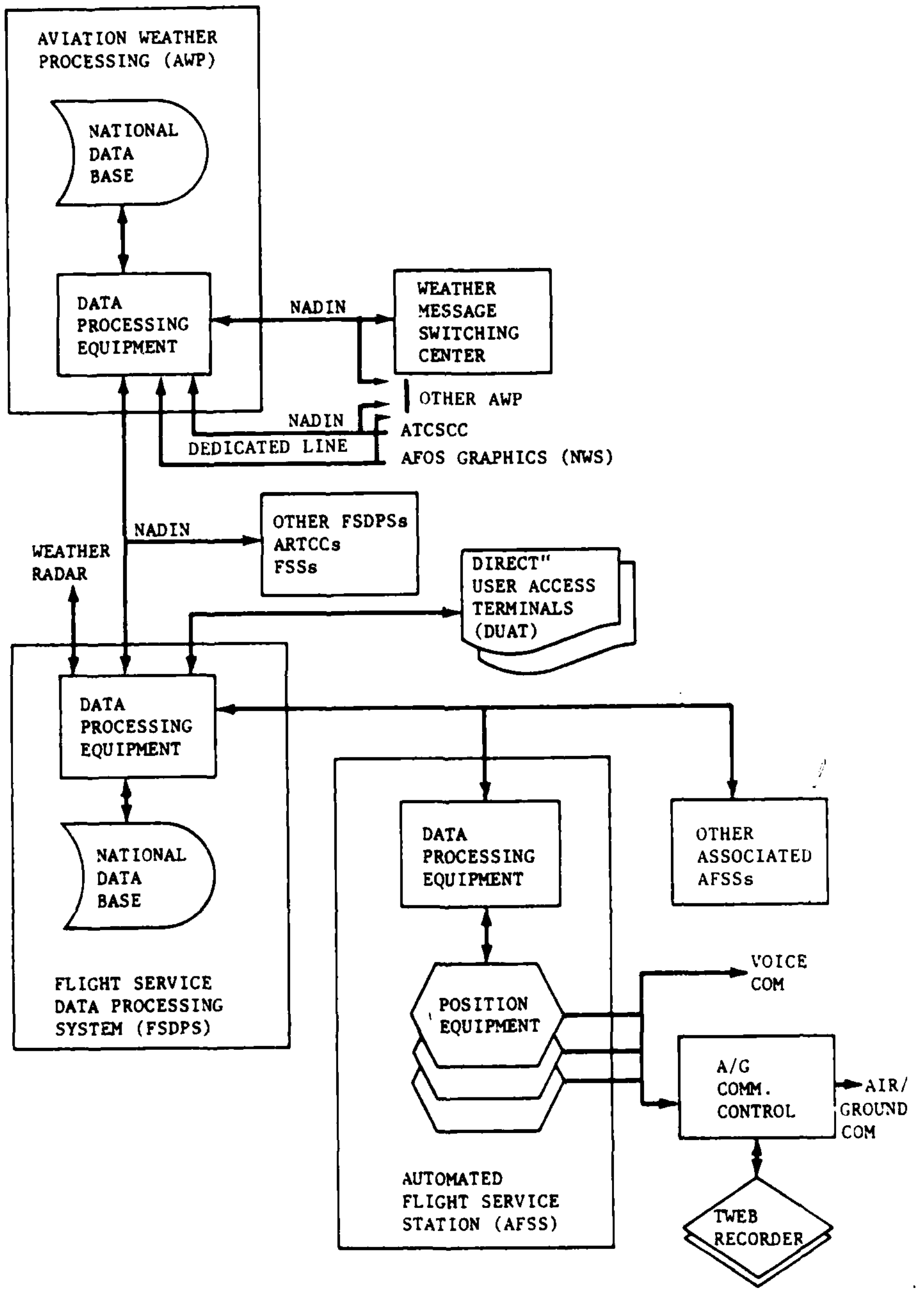


FIGURE 6-4
MODEL 2 FLIGHT
SERVICE FACILITIES

aeronautical information in the Model 2 system including the pilot oriented data base in which weather, and aeronautical information is reformatted and contractions are expanded for improved understandability.

In the Far Term, Weather Message Switching Center (WMSC) functions are to be incorporated in the expanded AWPs, improved weather radar will be available (NEXRAD) and an integrated Voice Response System capability will be provided along with the utilization of a Voice Recognition System. Three additional FSDPSs will be implemented (at San Juan, Honolulu and Anchorage) along with 5 more AFSSs. Figure 6-5 shows the extent of automated facilities with full Model 2 deployment. Non-automated FSSs will gradually be phased out during the Far Term when consolidation into the 61 AFSSs will be completed. The facilities provided at the FAA Technical Center (FAATC) for the support of the Flight Service automation program and the training facilities at Oklahoma City are not included in this chapter.

Improvements to Flight Service Facilities are described in Section 6.1 which follows. Additional information and details are provided in Section 6.2, Flight Service Facilities Connectivity, Section 6.3, Flight Service Facilities Tentative Implementation Schedule and 6.4 Flight Service Facilities Interface Planning Summary.

6.1 Flight Service Facilities Improvements

Improvements to Flight Service Facilities have two basic goals: one, to provide automated support to the Flight Service

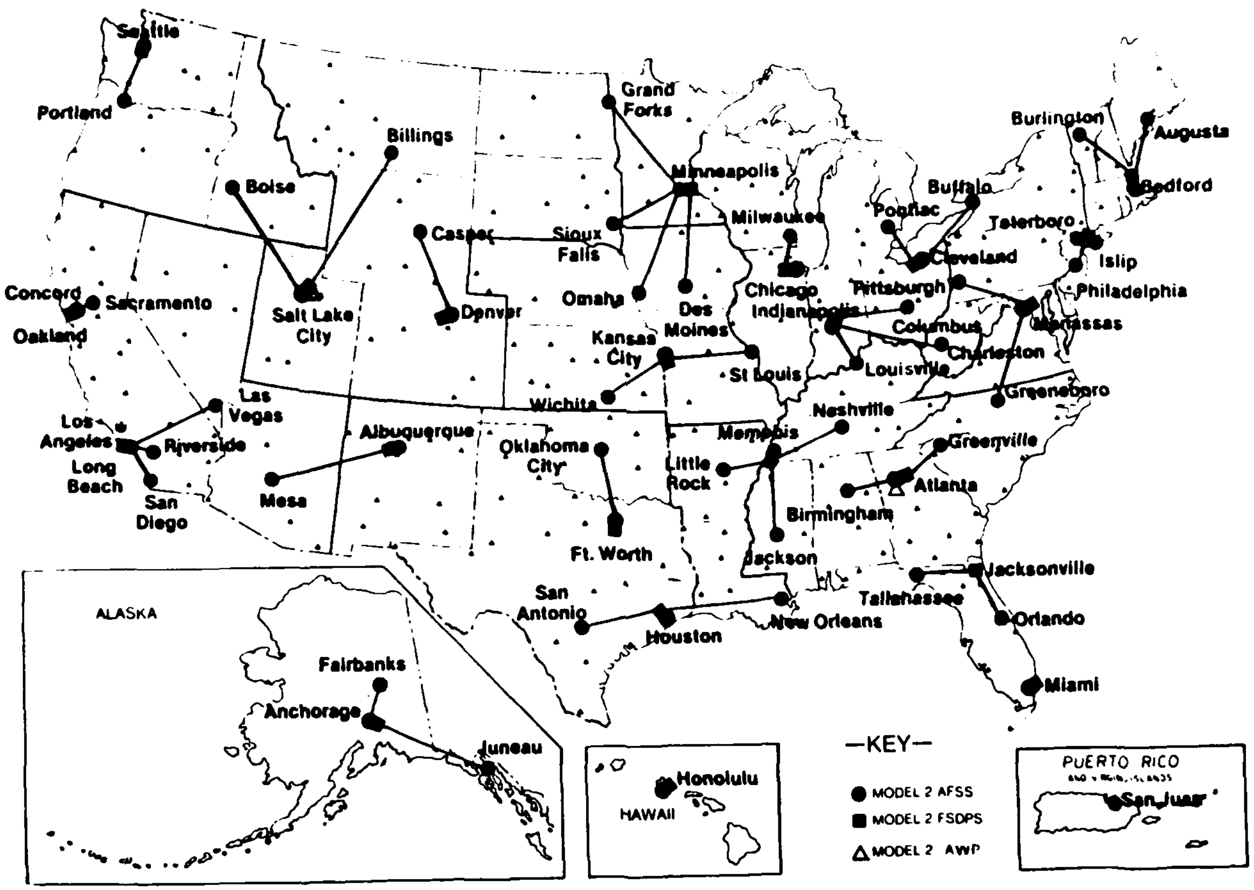


FIGURE 6-5
MODEL 2 FLIGHT SERVICE FACILITY LOCATIONS

Specialist in carrying out assigned functions, now primarily a manual and laborious process of shuffling paper and preparing inputs; and two, to make certain services directly accessible to pilots in a convenient and responsive way. The effect of the improvements is to make it possible for Flight service facilities to provide required services under increasing traffic loads in a more responsive way while minimizing the requirement for increased manning.

The functional breakout to be utilized throughout Chapter 6 is shown in the first column of Table 6-1, Flight Service Facilities Summary. It is intended to highlight those functions addressed in the improvements program and is not necessarily inclusive of all functions carried out at Flight Service Stations. In the third and fourth column, improvements planned for the Near Term are identified. These improvements are for the Automated Flight Service Stations under Model 1 and Model 2 of the Flight Service Station Automation Program. Model 1 will be the automated system during the time period 1982-1983 and will consolidate automated functions into a number of Automated Flight Service Stations. The third column summarizes Model 1 improvements to be implemented early in the Near Term. The fourth column, summarizes Model 2 improvements expected to be available later in the Near Term system (1983-1984) which will include the Aviation Weather Processor and additional functions at the FSDPS and AFSS. Each of the functions is described below along with the impact of improvements to each of the functions identified in the information flow diagrams (Figures 6-6, 6-7, 6-8 and 6-9). The weather briefing function is the primary operational service provided; the ordering of the functions is not intended to relate to load or priority. The

TABLE 6-1
FLIGHT SERVICE FACILITIES
IMPROVEMENTS SUMMARY

FUNCTIONS FEATURES	CURRENT SYSTEM (1980)	NEAR TERM IMPROVEMENTS (1981-1984)		FAR TERM I (POS
		MODEL 1 (1982-1983)	MODEL 2 (1983-1984)	
1. Emergency Assistance	a. Manual Message Generation b. Manual Location Plotting	a. NC b. NC	a. Automatic Message Generation b. Automated Location Calculation	a. NC b. NC
2. En route Flight Advisory Service (EFAS)	a. Manual PIREP Maintenance b. Manual Weather Plot and Retrieval	a. Automated Support to PIREP b. Manual Weather Plot and Automated Weather Retrieval	a. Enhanced Retrieval Filtering b. Improved Graphics/Radar	a. NC b. NC
3. Data Base Maintenance	Manual	Automated	Centralized and Expanded	AWP/WMS(
4. NOTAM Processing	Manual NOTAM Maintenance	Automated NOTAM Maintenance	Automated NOTAM Accounting	NC
5. Preparation of PATWAS/TWEB	a. Automated Weather Retrieval* b. Dictate Recordings	a. Automated Weather Retrieval b. NC	a. Selective Weather Retrieval b. Enhanced Recording	a. NC b. Voice Res,
6. Specialist Weather Briefing	a. Automated Data Retrieval* b. FAX CCTV Graphics c. Limited	a. Automated Weather Retrieval/ Display b. NC c. Radar at EFAS Locations	a. Selective, Filtered Retrieval/ Display b. Automated Graphic Display c. Direct/Dial-up of Multiple Radars	a. NC b. NC c. NEXRAD
7. Specialist Flight Plan Processing	a. Manual Entry/Addressing and Update b. Manual IFR Interaction with ARTCC c. NA d. Manual Suspense List	a. Automated Support to Entry and Update b. Minimal Manual IFR Interaction with ARTCC c. Weather Briefing Coordination d. Automated Alerts	a. Automated Amendment, Departure, Addressing b. NC c. NC d. NC	a. NC b. NC c. NC d. NC
8. PATWAS/TWEB Access	a. PATWAS via telephone b. TWEB via radio	a. PATWAS via Push-button Control b. NC	a. NC b. NC	a. Voice Reco. b. NC
9. Weather Observations	Manual Input	NC	NC	Joint Auto Weather Ob
10. Pilot Flight Plan Entry/Close	Fast File	NC	Automated via DUAT	Integrated
11. Pilot Weather Briefing	NA	NA	Automated via DUAT	Integrated

NC = No Change Included in Current Plans
NA = Not Applicable

*Leased Service A

	NEAR TERM (1983-1985)	FAR TERM IMPROVEMENTS (POST 1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
	a. Automatic Message Generation b. Automated Location Calculation	a. NC b. NC	
	a. Enhanced Retrieval Filtering b. Improved Graphics/Radar	a. NC b. NC	
	Centralized and Expanded	AWP/WMSC Consolidation	
	Automated NOTAM Accounting	NC	
	a. Selective Weather Retrieval b. Enhanced Recording	a. NC b. Voice Response System	
	a. Selective, Filtered Retrieval/Display b. Automated Graphic Display c. Direct Dial-up of Multiple Radars	a. NC b. NC c. NEXRAD	• Color Graphics • *Center Weather Service Unit Interface* • Specialist Assisted Voice Response System
	a. Automated Amendment, Departure, Addressing b. NC c. NC d. NC	a. NC b. NC c. NC d. NC	
	a. NC b. NC	a. Voice Recognition System b. NC	
	NC	Joint Automated Weather *Weather Observation Sytem* (JAWOS)	
	Automated via DUAT	Integrated Voice Response System	Support via DABS/Data Link
	Automated via DUAT	Integrated Voice Response System	Support via DABS/Data Link

TABLE 6-1
FLIGHT SERVICE FACILITIES
IMPROVEMENTS SUMMARY

INPUTS

FROM PILOT:
- Flight Plans/Amendments (7)(10)*
- Request for Assistance (1)
- Request for Current Weather (2)
- Pilot Reports (PIREPs) (2)
- Request for Weather Briefing (6)
- TWEB/PATWAS Request (8)
- Flight Plan Closures (7)

FROM NAVAIDS:
- Status Data (4)

FROM DF:
- Bearing Data (1)

FROM ARTCC:
- PIREPs (2)
- Coordination (7)

FROM NWS, MILITARY/FAA SOURCES (WMSC):
- Weather/Aeronautical Data Base (3)

FROM NWS:
- FAX Graphics (6)

FROM WEATHER RADARS SURVEILLANCE SITE:
- Weather Radar Image (6)

FROM OTHER FSS:
- VFR Flight Plans (7)
- Changes, Closures (7)
- Bearing Data (1)
- SAR Requests (1)

FROM TOWER CAB:
- Airport Conditions (6)
- Local Weather (6)

FROM SATELLITE FIELD SERVICE STATION:
- NOAA Satellite Pictures (6)

FROM SPECIALIST:
- Weather Observations (9)

*Indicates number of function input to or output from

FLIGHT SERVICE STATION (FSS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Manual Message Generation
   b. Manual Location Plotting
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. Manual PIREP Maintenance
   b. Manual Weather Plot and Retrieval
3. DATA BASE MAINTENANCE
   Manual
4. NOTAM PROCESSING
   Manual NOTAM Maintenance
5. PREPARATION OF PATWAS/TWEB
   a. Manual Weather Retrieval
   b. Dictate Recordings
6. SPECIALIST WEATHER BRIEFING
   a. Manual Data Retrieval
   b. FAX/CCTV Graphics
   c. Limited Weather Radar
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. Manual Entry, Addressing & Update
   b. Manual IFR Interaction with ARTCC
   d. Manual Suspense List
8. PATWAS/TWEB ACCESS
   a. PATWAS via Telephone
   b. TWEB via Radio
9. WEATHER OBSERVATIONS
   a. Manual Input
10. PILOT FLIGHT PLAN ENTRY (FAST FILE)

OUTPUTS

TO PILOT:
- Flight Plan Acceptance (7)
- Location Guidance (1)
- Current Weather (2)
- Forecast Weather (6)
- TWEB/PATWAS Briefing (8)

TO OTHER FSS:
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closures (7)
- Bearing Data (1)

TO ARTCC:
- IFR Flight Plans, Changes (7)
- Requests for PIREPs (2)

TO DF:
- Bearing Requests (1)

TO WMSC:
- Local Weather (3)
- NOTAMs (3)
- PIREPs (2)

TO TOWER CAB:
- Weather Reports (6)

FIGURE 6-6
CURRENT FLIGHT SERVICE FACILITIES
INFORMATION FLOW DIAGRAM

INPUTS

FROM PILOT:
- Flight Plans/ Amendments (7)(10)*
- Request for Assistance (1)
- Request for Current Weather (2)
- Pilot Reports (PIREPs) (2)
- Request for Weather Briefing (1)
- TWEB/PATWAS Request (8)
- Flight Plan Closures (7)

FROM NAVAIDS:
- Status Data (4)

FROM DF:
- Bearing Data (1)

FROM ARTCC:
- PIREPs (2)
- Coordination (7)

FROM NWS, MILITARY/FAA SOURCES (WMSC):
- Weather/Aeornautical Data Base (3)

FROM NWS:
- FAX Graphics (6)

FROM WEATHER RADAR SURVEILLANCE SITE:
- Weather Radar Image (6)

FROM FSS, FSDPS:
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closure (7)
- Bearing Data (1)

FROM TOWER CAB:
- Airport Conditions (6)
- Local Weather (6)

FROM SATELLITE FIELD SERVICE STATION:
- NOAA Satellite Field Service Station

FROM SPECIALIST
- Weather Observations (9)

*Indicates number of function input to or output from

AUTOMATED FLIGHT SERVICE STATION (AFSS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Manual Message Generation
   b. Manual Location Plotting
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. Automated Support to PIREPs
   b. Automated Weather Retrieval
3. DATA BASE MAINTENANCE
   Automated
4. NOTAM PROCESSING
   Automated NOTAM Maintenance
5. PREPARATION OF PATWAS/TWEB
   a. Automated Weather Retrieval
   b. Dictate Recording
6. SPECIALIST WEATHER BRIEFING
   a. Automated Data Retrieval/Display
   b. FAX/CCTV Graphics
   c. Radar at EFAS Sites
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. Automated Support to Entry and Update
   b. Minimal Manual IFR Interaction with ARTCC
   c. Weather Briefing Coordination
   d. Automated Alerts
8. PATWAS/TWEB ACCESS
   a. PATWAS via Push-button Control
   b. TWEB via Radio
9. WEATHER OBSERVATIONS
   Manual Input
10. PILOT FLIGHT PLAN ENTRY (FAST FILE)

OUTPUTS

TO PILOT:
- Flight Plan Acceptance (7)
- Location Guidance (1)
- Current Weather (2)
- Forecast Weather (6)
- TWEB/PATWAS Briefing (8)

TO FSS, FSDPS:
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closures (7)
- Bearing Data (1)

TO ARTCCs:
- IFR Flight Plans, Changes (7)
- Requests for PIREPs (2)

TO DF:
- Bearing Requests (1)

TO WMSC:
- Local Weather (3)
- NOTAMs (3)
- PIREPs (2)

TO TOWER CAB:
- Weather Reports (6)

Underlined words = changes from Current version to Near Term (Model 1) version of system.

FIGURE 6-7
NEAR TERM (MODEL 1) FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM

INPUTS

FROM PILOT:
- Flight Plans/Amendments (7)(10)
- Request for Assistance (1)
- Request for Current Weather (2)
- Pilot Reports (PIREPs) (6)
- Request for Weather Briefing (6)
- TWEB/PATWAS (8)
- Flight Plan Closures (7)

FROM NAVAID:
- Status Data (4)

FROM DF:
- Bearing Data (1)

FROM ARTCC:
- PIREPs (2)

FROM NWS, MILITARY/FAA SOURCES (WMSC)
- Extended Weather/Aeronautical Data Base (3)

FROM NWS:
- AFOS Graphics (6)

FROM OTHER FSS, FSDPS
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closure (7)
- Bearing Data (1)

FROM WEATHER RADAR SURVEILLANCE SITE:
- Weather Radar Image (6)NCE SITE:

FROM TOWER CAB:
- Airport Conditions (6)
- Local Weather (6)

FROM SATELLITE FIELD SERVICE STATION:
- NOAA Satellite Pictures (6)

FROM SPECIALIST
- Weather Observations (9)

AUTOMATED FLIGHT SERVICE STATION (AFSS) AND FLIGHT SERVICE DATA PROCESSING SYSTEM (FSDPS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Automatic Message Generation
   b. Automated Location Calculation
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. Enhanced Retrieval Filtering
   b. Improved Graphics/Radar
3. DATA BASE MAINTENANCE
   Centralized and Expanded
4. NOTAM PROCESSING
   Automated NOTAM Accounting
5. PREPARATION OF PATWAS/TWEB
   a. Selective Weather Retrieval
   b. Enhanced Recording
6. SPECIALIST WEATHER BRIEFING
   a. Selective, Filtered Retrieval/Display
   b. Automated Graphic Display
   c. Direct Dial-Up of Multiple Radars
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. Automated Amendment, Departure Addressing
   b. Minimal Manual IFR Interaction with ARTCC
   c. Weather Briefing Coordination
   d. Automated Alerts
8. PATWAS/TWEB ACCESS
   a. PATWAS via Push-button Control
   b. TWEB via Radio
9. Weather Observations
   Manual Input
10. PILOT FLIGHT PLAN ENTRY/CLOSE
   a. Automated via DUAT
11. PILOT WEATHER BRIEFING
   a. Automated via DUAT

OUTPUTS

TO PILOT:
- Flight Plan Acceptance (7)
- Location Guidance (1)
- Current Weather (2)(11)
- Forecast Weather (6)
  Summary
  Detailed
- TWEB/PATWAS Briefing (8)

TO OTHER FSS, FSDPS:
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closure (7)
- Bearing Data (1)

TO ARTCC:
- IFR Flight Plan, Changes (7)
- Request for PIREPs (2)

TO DF SITES:
- Bearing Requests (1)

TO WMSC:
- Local Weather (3)
- NOTAMs (3)
- PIREPs (2)

TO TOWER CAB:
- Weather Reports (6)

Underlined words = changes from Near Term (Model 1) version to Near Term (Model 2) version of system.

FIGURE 6-8
NEAR TERM (MODEL 2) FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM

INPUTS

FROM PILOT:
- Flight Plans/Amendments (7)(10)
- Request for Assistance (1)
- Request for Current Weather (2)
- Pilot Reports (PIREPs) (2)
- Request for Weather Briefing (6)
- TWEB/PATWAS (8)

FROM NAVAID:
- Status Data (4)

FROM DF:
- Bearing Data (1)

FROM ARTCC:
- PIREPS (2)
- Coordination (7)

FROM NWS, MILITARY/FAA SOURCES (WMSC):
- Extended Weather/Aeronautical Data Base (3)
- NOTAM Accounting Information (4)

FROM NWS:
- AFOS Graphics (6)

FROM OTHER FSS, FSDPS
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closure (7)
- Bearing Data (1)

FROM WEATHER RADAR SURVEILLANCE SITE:
- Weather Radar Image (6)

FROM TOWER CAB:
- Airport Conditions (6)
- Local Weather (6)

FROM JOINT AUTOMATED WEATHER OBSERVATIONS:
- Weather Observations(9)

FROM SATELLITE FIELD SERVICE STATIONS:
- NOAA Satellite Pictures (6)

AUTOMATED FLIGHT SERVICE STATION (AFSS) AND FLIGHT SERVICE DATA PROCESSING SYSTEM (FSDPS)

FUNCTIONS

1. EMERGENCY ASSISTANCE
   a. Automatic Message Generation
   b. Automated Location Calculation
2. EN ROUTE FLIGHT ADVISORY SERVICE
   a. Enhanced Retrieval Filtering
   b. Improved Graphics/Radar
3. DATA BASE MAINTENANCE
   AWP/WMSC Consolidation
4. NOTAM PROCESSING
   Automated NOTAM Accounting
5. PREPARATION OF PATWAS/TWEB
   a. Selective Weather Retrieval
   b. Voice Response System
6. SPECIALIST WEATHER BRIEFING
   a. Selective, Filtered Retrieval/Display
   b. Automated Graphic Display
   c. NEXRAD
7. SPECIALIST FLIGHT PLAN PROCESSING
   a. Automated Amendment, Departure, Addressing
   b. Minimal Manual IFR Interaction with ARTCC
   c. Weather Briefing Coordination
   d. Automated Alerts
8. PATWAS/TWEB ACCESS
   a. PATWAS with Voice Recognition
   b. TWEB via Radio
9. WEATHER OBSERVATIONS AUTOMATED INPUT
10. PILOT FLIGHT PLAN ENTRY/CLOSE
    a. Integrated VRS
11. PILOT WEATHER BRIEFING
    a. Integrated VRS

OUTPUTS

TO PILOT:
- Flight Plan Acceptance (7)
- Location Guidance (1)
- Current Weather (2)
- Forecast Weather (6)
  - Summary
  - Detailed
- TWEB/PATWAS Briefing

TO OTHER FSS, FSDPS:
- VFR Flight Plans, Changes (7)
- SAR Requests (1)
- Flight Plan Closure (7)
- Bearing Data (1)

TO ARTCC:
- IFR Flight Plan, Changes (7)
- Request for PIREPS (2)

TO DF SITES:
- Bearing Requests (1)

TO WMSC:
- Local Weather (3)
- NOTAMs (3)
- PIREPs (2)

TO TOWER CAB:
- Weather Reports (6)

Underlined words = changes from Near Term (Model 2) version to Far Term version of system.

FIGURE 6-9
FAR TERM FLIGHT SERVICE FACILITIES INFORMATION FLOW DIAGRAM

evolution of each function will be traced from the Current system through the Near Term system and the Far Term system. For each improvement, inputs, internal functions, outputs and operational results will be described. Changes to the flow of information over time will be described and required interface planning noted.

6.1.1 Emergency Assistance

Two aspects of emergency assistance are described here: one, assistance to an overdue aircraft, i.e., Search and Rescue (SAR) procedures, and two, assistance to a lost (disoriented) pilot. The SAR function is discussed first. In the Current system, if an aircraft becomes overdue (as noted from the inbound list) the appropriate sequence of search and rescue related messages is manually initiated. These messages are sent to the departure FSS and those FSSs along the route of flight, requesting information on the overdue aircraft and initiating a search and rescue Alert Notice as appropriate. Retrieval of data on the overdue aircraft is manual in each of the FSSs involved and the response must be manually generated.

In the Near Term Model 1 system, if an aircraft is overdue (as indicated by an automated alert), a specialist at the destination AFSS manually initiates and addresses the proper sequence of search and rescue messages. The automatic retrieval of data on the overdue aircraft is requested by specialists at the departure or en route AFSS and must be manually addressed to the requesting AFSS. (Where manual Flight Services Stations are involved, their processing remains as described under the Current system.)

In the Near Term Model 2 system, when an automatic alert is generated at the destination AFSS, the required search and rescue messages are automatically generated and displayed to the specialist at the destination AFSS prior to transmittal. The system will determine the addresses of other AFSSs (e.g., departure, en route) which should receive search and rescue messages. At each AFSS/FSDPS involved, requested information will be automatically retrieved and the responses automatically generated for display to a specialist prior to transmission. (Processing at manual FSSs remains as described under the Current system.)

Over time, the information flow for this function is gradually automated and communications are improved. The operational result is a more effective use of the specialist, an increased system reliability and a decreased system response time.

Assistance to a lost or disoriented pilot is provided in the Current system by utilizing the direction finder at the FSS in contact with the pilot to get a bearing which is manually plotted by a Flight Service Specialist. This involves manual tuning of receivers and verbal confirmation of signals. The specialist may also get other directional/locational information from the pilot (e.g., VOR radial), or time/distance checks may be done on sequential pilot transmissions to locate the pilot's position. The pilot is then given direction guidance to a safe location.

In the Near Term Model 1, the procedure is the same. In the Near Term Model 2, the specialist enters bearing information into the FSDPS which will solve the navigational problems of

location and compute the heading to a requested location. Primary inputs and outputs to the pilot remain the same; however, the support to the specialist in locating the aircraft and providing a heading to a safe location is automated. The operational effect is to provide a faster system response and more effective utilization of the specialist.

6.1.2 En Route Flight Advisory Service (EFAS)

Forty-four Flight Service Stations provide an En Route Flight Advisory Service (EFAS), a specialized system providing near real-time weather service directly to pilots in flight. In the Current system, the Flight Watch Specialist (FWS) who provides the service will enter Pilot Reports (PIREPs) into the system over Service A teletype. These are then forwarded to the WMSC for entry into the national data base and subsequent distribution. The FWS will manually maintain files of PIREPs and will maintain a manual plot of current weather conditions for the area of responsibility (600 nautical mile radius of the Facility). When the specialist is contacted by inflight pilots, they will be provided with current weather conditions. Furthermore, the FWS may contact pilots to solicit PIREPs on local weather conditions of interest and may coordinate that activity with the ARTCC responsible for that area.

In the Near Term Model 1, the input and maintenance of PIREP information is supported by the automated system at the FSDPS. PIREP entry may be made at the AFSS either in fixed or random format and the system will place the message in transmission format and send it to the WMSC. PIREP retrieval is provided by the system for specified locations and will include PIREPs

received from the WMSC as well as PIREPs entered at the AFSS. PIREP retrieval may be filtered so that only those PIREPs with information in selected fields will be retrieved. As in the Current system, a manual weather plot may be maintained. This may be supplemented by automated weather retrieval in the Near Term system.

In the Far Term, the FWS will have the full range of weather retrievals available. Improved graphic products from the NWS Automation of Field Operations and Services (AFOS) system and weather radar displays are also expected to be available. PIREPs may be retrieved for a corridor along the route of flight or by distance from a location.

Over time, the flow of information to and from the pilot remains about the same. However, the flow of information to and from the WMSC is improved by both the automated assistance to PIREP entry and the improved communication capabilities. The functions performed by the FWS are progressively automated to provide data base maintenance and retrieval as well as improved graphics products.

6.1.3 Data Base Maintenance

This function is to a large extent basic to all the others. Improvements in it are reflected in the others. In the Current system, inputs to the system are over the teletype networks (Service B for flight information and Service A for weather and NOTAMs). There is little or no automatic error checking. Data maintenance for flight information is manual and involves keeping hard copy reports organized for convenient searching and

retrieval of information. Storage and retrieval of weather and aeronautical information is accomplished utilizing the leased Service A system. This system is installed at 150 FSSs. Graphic products are available by facsimile network from NWS.

In the Near Term Model 1, automated support is provided for the input of information and for maintenance (update) of the data base. Specialist inputs are in either fixed or variable format with error checking performed. New weather inputs from WMSC replace outdated weather in the data base.

In both the Near Term Model 2 and in the Far Term, data base maintenance functions for the Flight Service Automation System are shared between the two Aviation Weather Processor (AWP) and the Flight Service Data Processing Systems (FSDPSs).

6.1.3.1 Aviation Weather Processor

Weather and aeronautical information from WMSC is received at the AWPs where a number of centralized processes are performed. Reformatting of the information and expansion of contractions is automatically done for the weather and aeronautical data base to be used in support of pilot briefings (e.g., via DUATs). Surface Observations and Pilot Reports are reformatted but all other messages from WMSC are utilized as received (except for manual editing) for the data base to be used in support of the FSS specialists. Graphic data from the NWS AFOS system is also received at the AWP. Manual editing including manual entry of graphics is planned for the AWP. Centralized maintenance is also performed at the AWP on Preferred Routes, the Law Enforcement file and Special Use Areas. Periodic data base

updates are sent to the FSDPSs and a complete data base is supplied when needed (e.g., start-up).

In the far term, WMSC functions will be incorporated into expanded AWPs. These functions include the weather and aeronautical data gathering, data base maintenance and weather and aeronautical data distribution functions now performed at the WMSC.

6.1.3.2 FSDPSs

Data base maintenance except for local inputs is automatic at the FSDPSs in the Near Term Model 2 and the Far Term. As new information is received from the AWP it automatically replaces older data. Weather radar inputs are maintained for up to 13 radar sites and radar images are automatically redistributed to each AFSSs. Graphics (e.g., AFOS products) are also automatically maintained at the FSDPSs and redistributed to the AFSSs.

6.1.4 NOTAM Processing

NAVAID monitoring and control is performed at the Flight Service Station by monitoring a status panel and by switching in alternate NAVAIDs as needed. The Flight Service Stations are the prime source of entry of the Notices to Airmen (NOTAM) into the national aviation data base. When outages occur or are reported in the Current system, the specialist enters the information into the teletype system and manually maintains a file for local use. This requires strict manual accounting procedures and lists to insure data integrity. In the Near Term

Model 1 automated support is provided to the entry and distribution of NOTAMs. As the specialist receives notification of airport conditions or determines NAVAID outages, the information is entered by the specialist in the format provided by the computer. The program will automatically transmit the NOTAM to the WMSC for nationwide distribution. Also the specialist may enter a suspense time when the computer program will recall the NOTAM for appropriate follow-on action (e.g., reentry, cancellation). In the Near Term Model 2, automated NOTAM accounting will be provided and NAVAID status information is expected to be provided by the Remote Maintenance and Monitoring System (RMMS).

6.1.5 Preparation of PATWAS/TWEB

In the Current system, weather and aeronautical information retrieval for recording Pilot Automatic Telephone Weather Answering Service (PATWAS) and Transcribed Weather Broadcast (TWEB) information is done manually by the specialist. TWEB reports or TWEB synopsis from NWS may be used along with PIREPs, NOTAMs and other information as appropriate. The specialist dictates into the recording mechanism the specific weather report compiled for each PATWAS and TWEB outlet. Generally, the emphasis is on current weather or developing inclement conditions. In the Near Term Model 1 system, weather retrieval for use in PATWAS and TWEB recording is done by the automated system which may utilize prespecified sequences of weather and aeronautical messages by specified location or locations (which can define PATWAS or TWEB routes) or weather reports may be retrieved by location or route. The predefined sequences may specify appropriate combinations of prepared text messages and

current weather messages for the respective PATWAS or TWEB routes in order to present to the specialist all required information for each PATWAS or TWEB report. The specialist then uses this information to record the reports as in the Current system. The number of reports available to the pilot is to be expanded for the Near Term .

In the Near Term Model 2 system, weather and aeronautical information retrieval can be route-oriented or by location and can be by prespecified sequences. The capability to retrieve weather and aeronautical information tailored to the specific formats and data to be entered into the PATWAS and TWEB recordings would be available. In the Far Term individual reports would be entered into the PATWAS/TWEB utilizing Voice Response System support.

Over time, increasing automated support is provided to the specialist in preparing PATWAS and TWEB recordings by first automating the retrieval of weather and aeronautical information, and later by the introduction of support from the Voice Response System.

6.1.6 Specialist Weather Briefing

The weather briefing function draws on a large national data base of weather and aeronautical information. Table 6-2 lists the general categories of information.

In the Current system, the specialist must search through files of teletype reports or recall weather conditions in order to present a weather briefing to a pilot. The teletype reports of

TABLE 6-2
WEATHER AND AERONAUTICAL INFORMATION CATEGORIES

- Surface Aviation Weather Observations (Domestic, Military, Canadian, Mexican, Caribbean, Alaskan)
- Aviation Terminal Forecasts (Domestic, Military, Canadian, Mexican and Caribbean)
- Notices to Airmen (NOTAMs)
- Flight Data Center (FDC) NOTAMs and FDC NOTAM Cancellations
- Central Altitude Reservation Facility (CARF) NOTAMs and CARF NOTAM Cancellations
- International NOTAMs
- Area Forecasts (Domestic, Canadian, Mexican and Caribbean)
- Significant Meteorological Information
- Airmen's Meteorological Information
- Pilot Reports (Domestic, Alaskan)
- TWEB Routes and Synopses
- Hurricane Advisories
- Severe Weather Forecasts and Bulletins
- *Severe Weather Outlook*
- Grid Winds
- Radar Reports (Domestic, Canadian, Caribbean)
- ATC System Command Center (ATCSCC) Messages
- Military Operations Messages
- AFOS Graphic Products
- Tropical Depression Advisories
- Prognostic Map Discussion

weather and aeronautical conditions are manually searched for information of importance to the pilot for the particular flight being planned. Graphic products (including NOAA satellite pictures) available to the specialist are received over a facsimile network and are further available over closed circuit television at some facilities. Weather radar displays are available in those FSSs having an EFAS capability.

In the Near Term Model 1 system, retrieval of weather and aeronautical conditions from the data base is automated and can be by predefined sequences of message types, by specific location and weather type, or can be area or route-oriented. The retrieved information is presented to the specialist on a display. Graphic products from NWS and the Satellite Field Service Station are made available more conveniently using closed circuit television at the majority of Model 1 facilities.

In Near Term Model 2, the retrieval of weather and aeronautical conditions for the specialist is even more flexible and more selective. Route-oriented briefings may utilize preferred routes available from the system, filtering of reports on the basis of weather conditions is utilized (i.e., if there are no significant weather phenomena the report is not displayed). Graphic displays (including AFOS products) and weather radar would be retrieved from the data base; these would be viewed on a separate video terminal by the specialist.

The automation of weather and aeronautical data retrieval and display to the specialist is progressively improved to be more flexible and increasingly selective in order to provide the needed information more quickly and with the minimum amount of excess information.

6.1.7 Specialist Flight Plan Processing

In the Current system, when a specialist receives required information from a pilot wishing to file a flight plan, the specialist will note the information while talking to the pilot. The flight plan is then entered into the Service B teletype network in a highly structured format and addressed to the destination FSS if it is VFR or to the departure ARTCC if it is IFR. Error notifications or rejections from the addressees must be corrected in the same structured format and addressed to the specific locations. Subsequent amendment, departure and flight plan close messages must be entered in a similar fashion. Coordination with ARTCCs is accomplished via telephone or utilizing the manual process described above. In the Near Term Model 1 system, the specialist will request a flight plan format on the video terminal when a pilot requests assistance in filing a flight plan. As the pilot gives information to the specialist, the specialist will enter it in the proper fields until the required information is complete. The specialist will then indicate whether the flight plan is to be transmitted to an ARTCC (for IFR flights) or sent to the destination facility when activated (in the case of VFR). In both Model 1 and Model 2, flight plan information entered in the process of a weather briefing will be retained temporarily by the system for use in building a flight plan message so such information will not have to be reentered.

In the Current system a list of incoming flights is manually maintained by the specialist and is used to determine if flights are overdue. In the Near Term and Far Term systems, the list of incoming flights is automatically maintained by the system.

Flights that are overdue (i.e., not closed or cancelled, within a specified time of expected arrival) will cause an automatic system alert at a specialist position.

In the Near Term Model 2 system and the Far Term system, such alerts will also cause the system to prepare Search and Rescue messages for review and possible use by the specialist.

6.1.8 Weather Observations

In the Current system, weather observations may be taken at an FSS. In addition to local use, these observations are the basis for weather messages which are manually entered into the Service A network for transmission to the WMSC and redistribution nationwide. In the Near Term Model 1 and Model 2 system, such weather observations will continue to be made and weather messages will be entered via specialist terminals at AFSSs or manually at non-automated FSSs into the Service A, ABDIS or NADIN network for transmission to the WMSC and nationwide redistribution. In the Far Term, it is anticipated that the Joint Automated Weather Observation System (JAWOS) will provide a means of automatically providing weather observations for local use as well as for retransmission to WMSC (or combined AWP/WMSC) for nationwide distribution.

6.1.9 PATWAS/TWEB Access

In the Current system, PATWAS access is via telephone. The pilot must dial the specific number to get the local or PATWAS route information required. In the Near Term and Far Term systems, one telephone number will have a selection of routes or

local briefings available by utilizing push-button control. In the Far Term, PATWAS access may also utilize a Voice Recognition System. TWEB access is available via radio throughout the time periods covered.

6.1.10 Pilot Flight Plan Entry/Close

In the Current and Near Term Model 1 systems, the pilot does not have direct access to the system for filing or closing flight plans. The pilot may, however, utilize the Fast File capability which will record flight plan information for subsequent entry into the system by a specialist. In the Near Term Model 2 system, the pilot may use a DUAT to enter flight plans. On a DUAT, entries are made in a conversational mode, and if the filing is in conjunction with a weather briefing, flight plan information entered during the course of the weather briefing is retained temporarily by the system and is available to the pilot to use without reentry. Also the DUAT may be used for cancelling or closing a flight plan.

In the Far Term, DUAT support is extended and the Voice Response System (VRS) is used in conjunction with entries on a push-button equipped telephone. In the case of VRS the system will echo each element of the flight plan entered by the pilot for confirmation or correction. Flight data entered into the system by a pilot is transmitted to the departure ARTCC in the case of IFR and to the departure and arrival AFSS in the case of VFR.

6.1.11 Pilot Weather Briefing

Except for PATWAS (and TWEB) the pilot does not have direct

access to the system for a weather briefing until Near Term Model 2. In that system, a Direct User Access Device (DUAT) may be used by a pilot to carry out an interactive session with the FSDPS to get a briefing on weather and aeronautical information either on a route-oriented or specific location basis. If the DUAT is capable of displaying graphics, appropriate graphics will be presented as part of the briefing. If not, area forecasts will be displayed for the indicated route of flight.

In the Far Term, a pilot may use push-button equipped telephone to request local or route-oriented briefings from the Voice Response System. Pilot briefings are presented by the system utilizing the special data base in which weather and aeronautical messages have been reformatted and contractions have been expanded.

Voice Response capabilities are also being pursued independent of any specific FSAS model and could be implemented as a separate system much earlier depending on the results of configuration and requirement studies underway.

6.1.12 Improvements Dependencies

The most notable dependency between the improvements is the dependency of the briefing functions, the primary operational task, on the automated data base maintenance function. In fact, all the improvements are to some extent dependent on the improved data base maintenance. Improved specialist support, in Model 2, is dependent on the improved consoles and displays as well as data maintenance automatically performed at the AWP and FSDPS. Editing functions (including graphic capabilities)

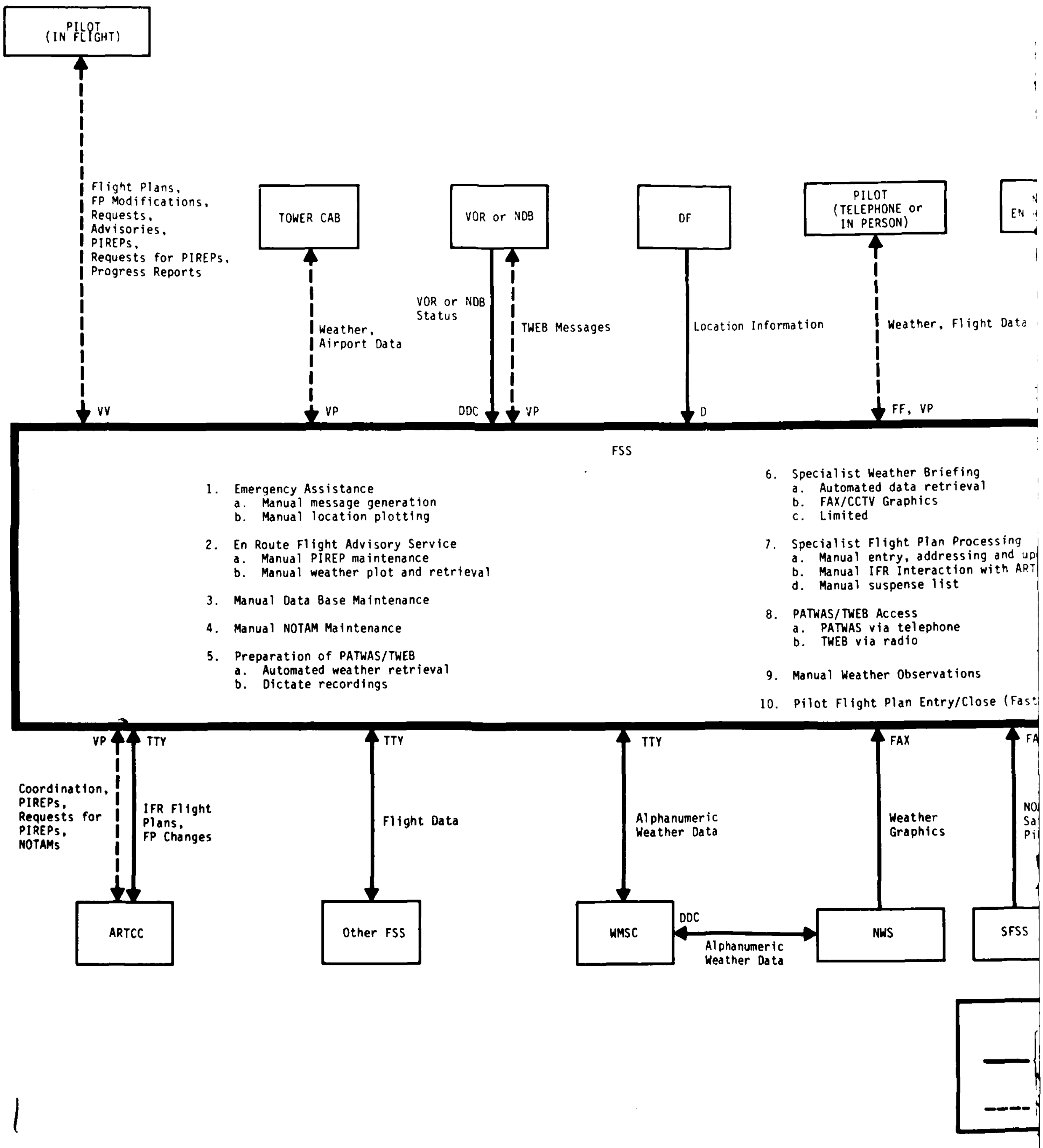
expected to be available at the AWP will further enhance the useability of the national data base of weather and aeronautical information. Improved graphics are dependent on the availability of the AFOS data from NWS. Improved weather radar at the AFSS is dependent on the availability and remoting of the necessary radar facilities. Direct support to the pilot provided under improvements 9 and 10 as cited in Table 6-1 are dependent on the expanded data base developed at the AWP (i.e., expanded contractions and reformatting) and on the development of the Voice Response System.

6.1.13 Potential and Longer Range Improvements

Potential and Longer Range Improvements to the Flight Service Facilities include the use of color graphics, the utilization of DABS data link for pilot support, voice response assistance to the specialist, and the Center Weather Service Unit (CWSU) interface under the Aviation Weather System (AWES) program. Studies and/or plans in each of these areas could result in new requirements for the Flight Service Facilities to support and corresponding new improvements in capabilities.

6.2 Flight Service Facilities Connectivity

In this section, the connections to other facilities are described, emphasizing the type of information passed over the connection. Telephone connections and connections for passing general information or administrative information are not covered. There are four figures which illustrate the various connections over the time periods covered in this report: Figure 6-10 for the Current system, Figure 6-11 and 6-12 for the


PILOT (IN FLIGHT)
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
VV
TOWER CAB
Weather, Airport Data
VP
VOR or NDB
VOR or NDB Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT (TELEPHONE or IN PERSON)
Weather, Flight Data
FF, VP
FSS
1. Emergency Assistance
a. Manual message generation
b. Manual location plotting
2. En Route Flight Advisory Service
a. Manual PIREP maintenance
b. Manual weather plot and retrieval
3. Manual Data Base Maintenance
4. Manual NOTAM Maintenance
5. Preparation of PATWAS/TWEB
a. Automated weather retrieval
b. Dictate recordings
6. Specialist Weather Briefing
a. Automated data retrieval
b. FAX/CCTV Graphics
c. Limited
7. Specialist Flight Plan Processing
b. Manual IFR Interaction with ART
d. Manual suspense list
8. PATWAS/TWEB Access
a. PATWAS via telephone
b. TWEB via radio
9. Manual Weather Observations
VP
TTY
Coordination, PIREPs, Requests for PIREPs, NOTAMs
IFR Flight Plans, FP Changes
ARTCC
TTY
Flight Data
Other FSS
TTY
Alphanumeric Weather Data
WMSC
DDC
Alphanumeric Weather Data
FAX
Weather Graphics
NWS
SFSS

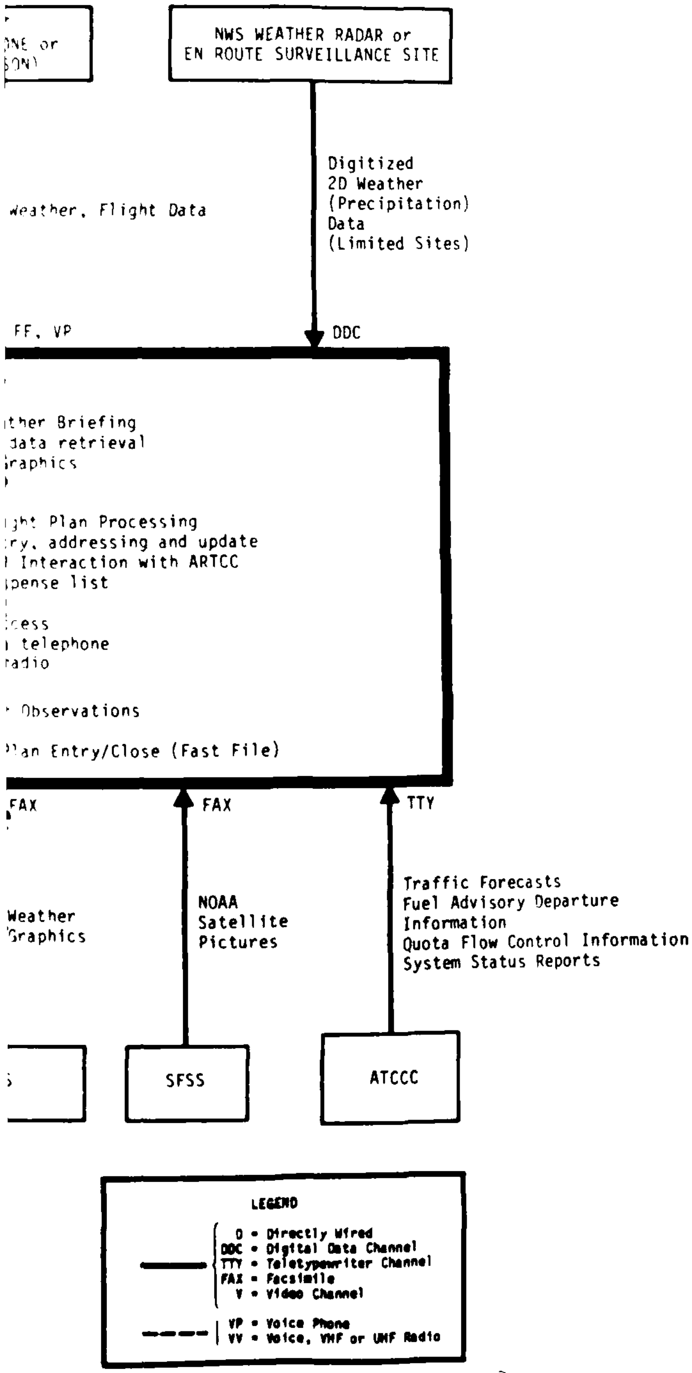
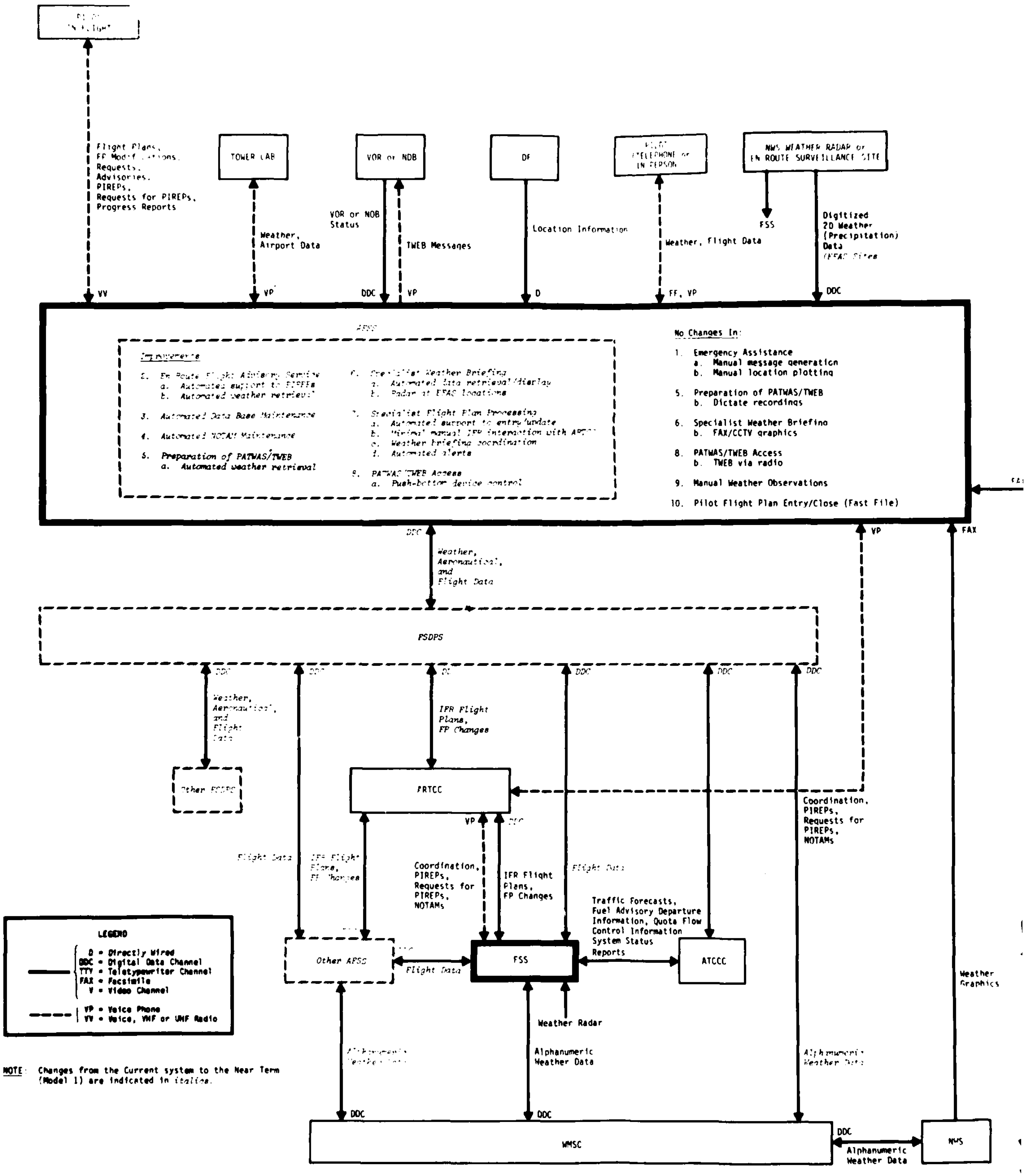


FIGURE 6-10
CURRENT FLIGHT SERVICE FACILITIES
CONNECTIVITY DIAGRAM


TOWER CAB
VOR or NDB
DF
NWS WEATHER RADAR or EN ROUTE SURVEILLANCE SITE
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
Weather, Airport Data
VOR or NDB Status
TWEB Messages
Location Information
Weather, Flight Data
FSS
Digitized 2D Weather (Precipitation) Data
VV
VP
DDC
VP
D
FF, VP
DDC
No Changes In:
1. Emergency Assistance
a. Manual message generation
b. Manual location plotting
5. Preparation of PATWAS/TWEB
b. Dictate recordings
6. Specialist Weather Briefing
b. FAX/CCTV graphics
8. PATWAS/TWEB Access
b. TWEB via radio
9. Manual Weather Observations
10. Pilot Flight Plan Entry/Close (Fast File)
5. Preparation of PATWAS/TWEB
a. Automated weather retrieval
Weather, Aeronautical, and Flight Data
FSDPS
IFR Flight Plans, FP Changes
VP
FAX
ARTCC
Coordination, PIREPs, Requests for PIREPs, NOTAMs
IFR Flight Plans, FP Changes
Traffic Forecasts, Fuel Advisory Departure Information, Quota Flow Control Information, System Status Reports
Other AFSS
Flight Data
FSS
ATCCC
Weather Radar
Alphanumeric Weather Data
Weather Graphics
LEGEND
D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
FAX = Facsimile
V = Video Channel
VP = Voice Phone
VV = Voice, VHF or UHF Radio
NOTE: Changes from the Current system to the Near Term (Model 1) are indicated in italics.
DDC
DDC
WMSC
DDC
Alphanumeric Weather Data
NWS

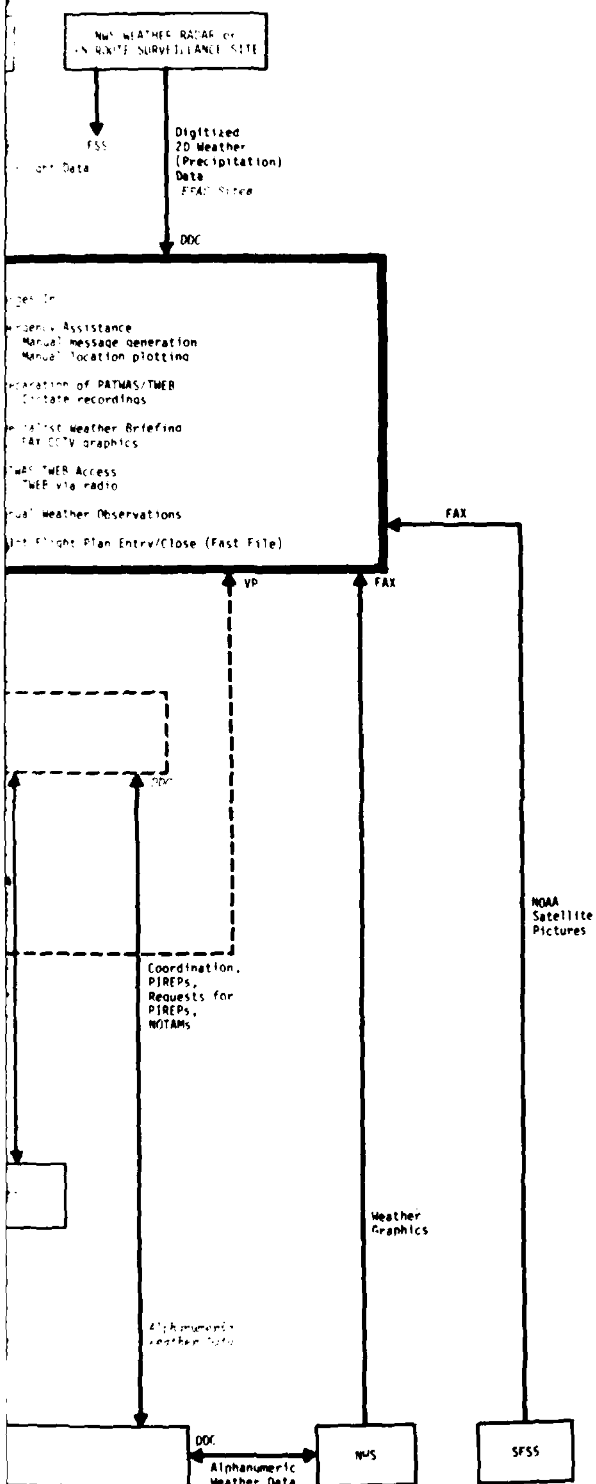
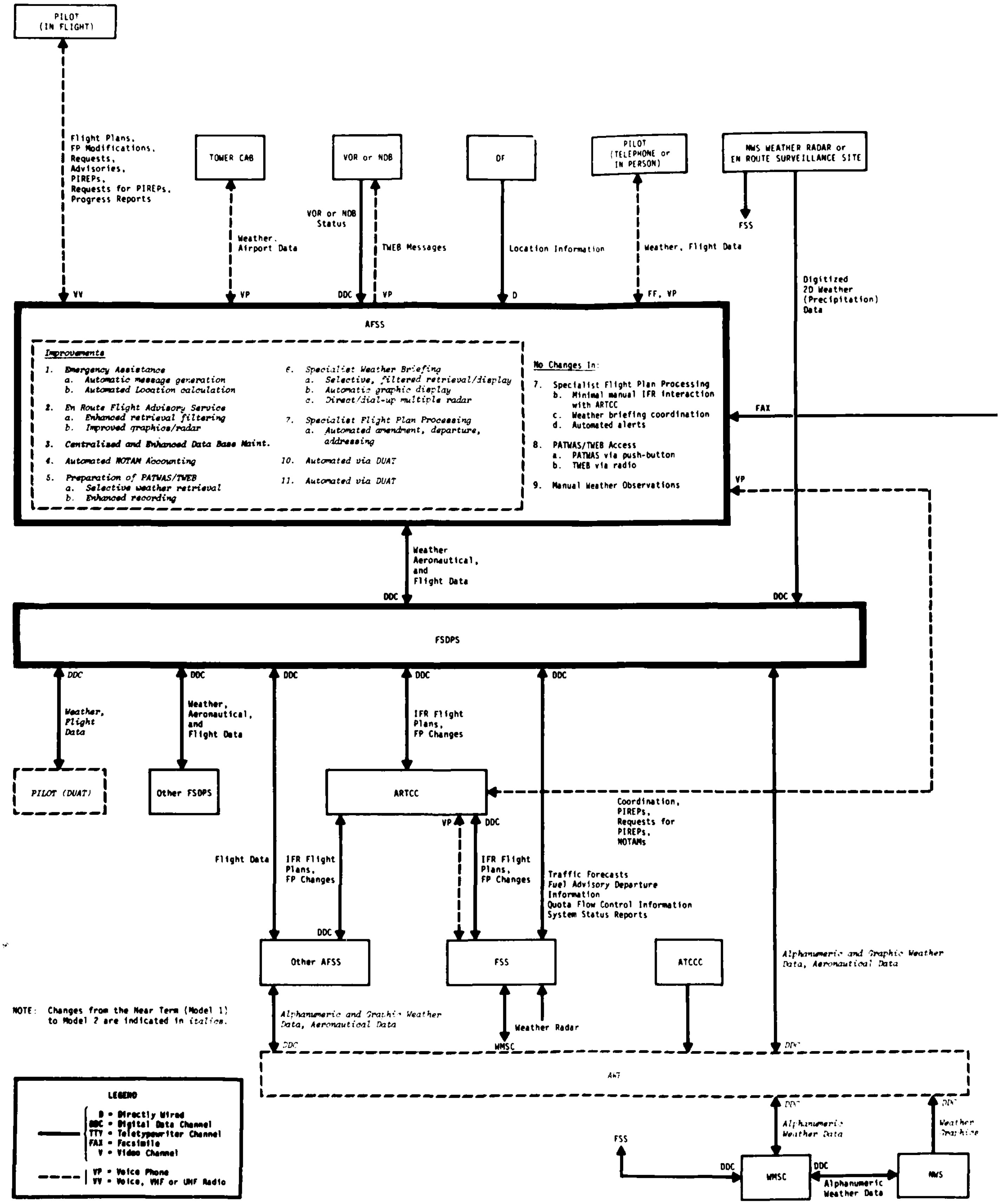


FIGURE 6-11
NEAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM
(MODEL 1)

PRECEDING PAGE BLANK-NOT FILMED



PILOT (IN FLIGHT)
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
VV
TOWER CAB
Weather, Airport Data
VP
VOR or NDB
VOR or NDB Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT (TELEPHONE or IN PERSON)
Weather, Flight Data
FF, VP
NWS WEATHER RADAR or EN ROUTE SURVEILLANCE SITE
FSS
Digitized 2D Weather (Precipitation) Data
AFSS
Improvements
1. Emergency Assistance
a. Automatic message generation
b. Automated Location calculation
2. En Route Flight Advisory Service
a. Enhanced retrieval filtering
b. Improved graphics/radar
3. Centralized and Enhanced Data Base Maint.
4. Automated NOTAM Accounting
5. Preparation of PATWAS/TWEB
a. Selective weather retrieval
b. Enhanced recording
6. Specialist Weather Briefing
a. Selective, filtered retrieval/display
b. Automatic graphic display
c. Direct/dial-up multiple radar
7. Specialist Flight Plan Processing
a. Automated amendment, departure, addressing
10. Automated via DUAT
11. Automated via DUAT
No Changes In:
7. Specialist Flight Plan Processing
b. Minimal manual IFR interaction with ARTCC
c. Weather briefing coordination
d. Automated alerts
8. PATWAS/TWEB Access
a. PATWAS via push-button
b. TWEB via radio
9. Manual Weather Observations
FAX
VP
Weather Aeronautical, and Flight Data
DDC
DDC
FSDPS
DDC
Weather, Flight Data
PILOT (DUAT)
DDC
Weather, Aeronautical, and Flight Data
Other FSDPS
DDC
DDC
IFR Flight Plans, FP Changes
ARTCC
DDC
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Flight Data
IFR Flight Plans, FP Changes
DDC
VP
DDC
IFR Flight Plans, FP Changes
Traffic Forecasts
Fuel Advisory Departure Information
Quota Flow Control Information
System Status Reports
Other AFSS
FSS
ATCCC
Alphanumeric and Graphic Weather Data, Aeronautical Data
NOTE: Changes from the Near Term (Model 1) to Model 2 are indicated in italics.
Alphanumeric and Graphic Weather Data, Aeronautical Data
DDC
Weather Radar
WMSC
DDC
AWN
DDC
Alphanumeric Weather Data
DDC
Weather Graphics
FSS
DDC
WMSC
DDC
Alphanumeric Weather Data
NWS
LEGEND
D = Directly Wired
DDC = Digital Data Channel
TTY = Teletypewriter Channel
FAX = Facsimile
V = Video Channel
VP = Voice Phone
VV = Voice, VHF or UHF Radio

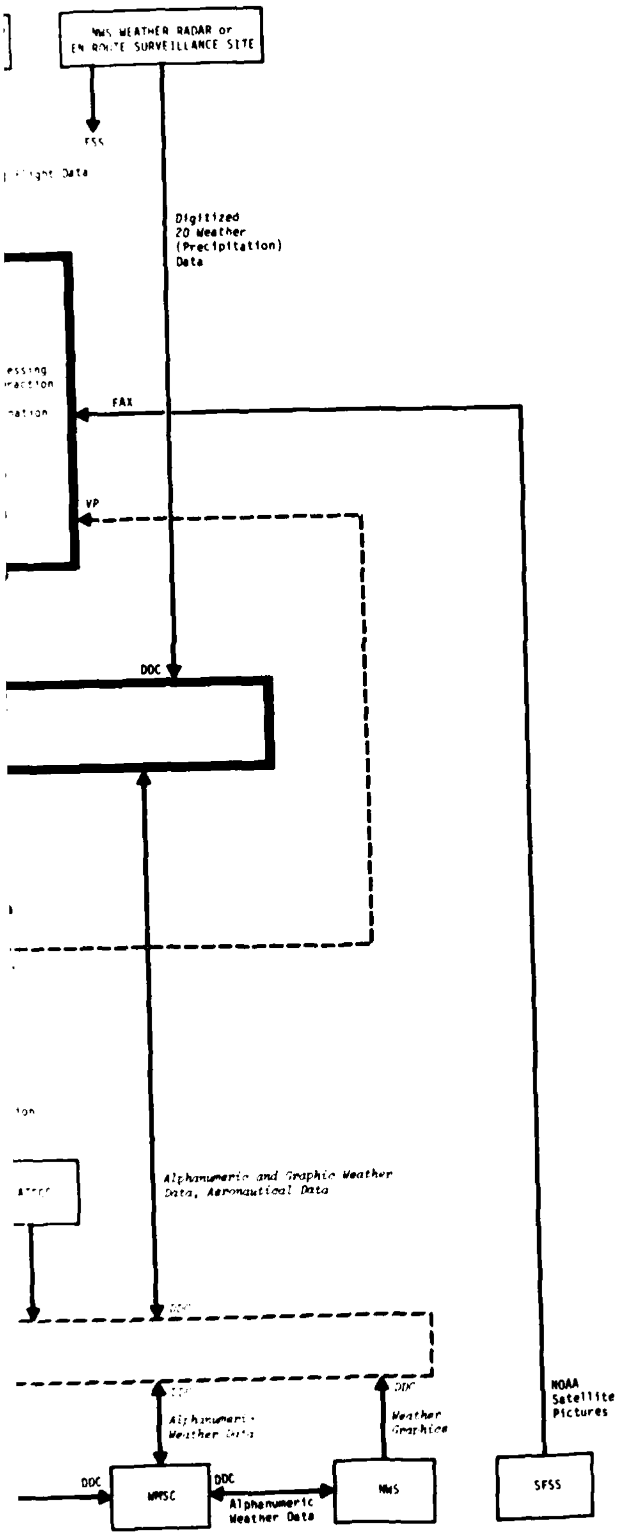


FIGURE 6-12
NEAR TERM FLIGHT SERVICE FACILITIES CONNECTIVITY DIAGRAM
(MODEL 2)

2

Near Term and Figure 6-13 for the Far Term. Each of the connections will be described below over the three time periods.

6.2.1 National Weather Service

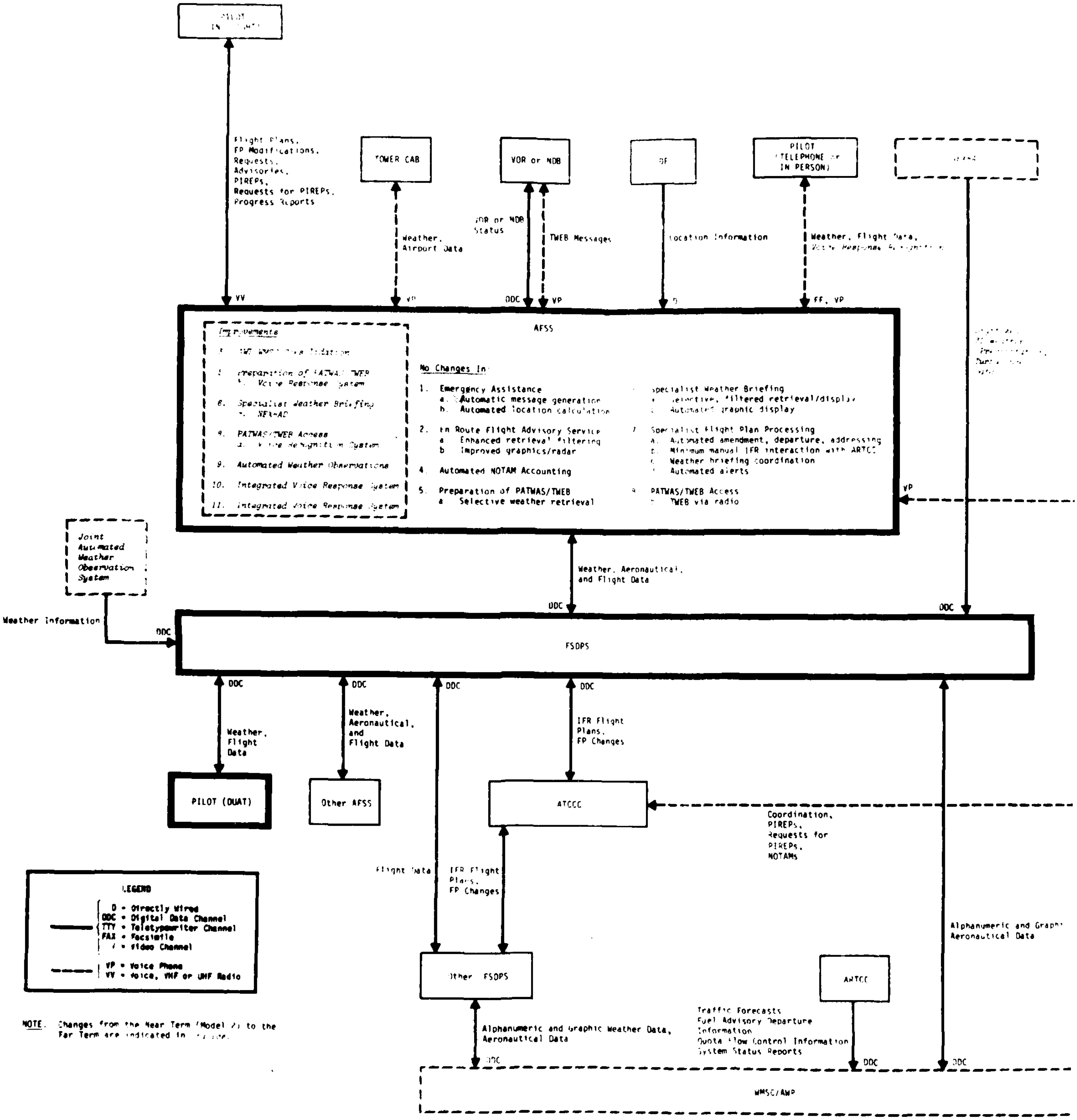
In the Current system, the National Weather Service (NWS) provides graphic charts over a facsimile circuit. This capability is also available in the Near Term Model 1. Starting with Model 2, improved graphics products from the AFOS system will be sent to the AWP via data channel. Editing and combining of graphic products may also be performed and the products are made available for use by the specialist at the AFSS or the pilot via a DUAT.

6.2.2 Satellite Field Service Station

In the current system and through Model 2, graphic products in the form of National Oceanic Atmospheric Administration (NOAA) satellite pictures are received at some of the FSSs and/or AFSSs. In the Far Term it is assumed that digitized data is secured at the combined WMSC/AWP for retransmission to the FSDPs (and AFSSs) nationwide.

6.2.3 Weather Message Switching Center

The Weather Message Switching Center (WMSC) gathers alphanumeric (A/N) weather and aeronautical information from a number of sources including NWS and FSS sources. It is the primary source of such national data for the Flight Service Facilities. In the Current and Near Term Model 1 systems, this data is received by the Flight Service Stations over Service A teletype lines. With the adoption of NADIN I, NADIN circuits are utilized to transmit



NOTE. Changes from the Near Term (Model 2) to the Far Term are indicated in italics.

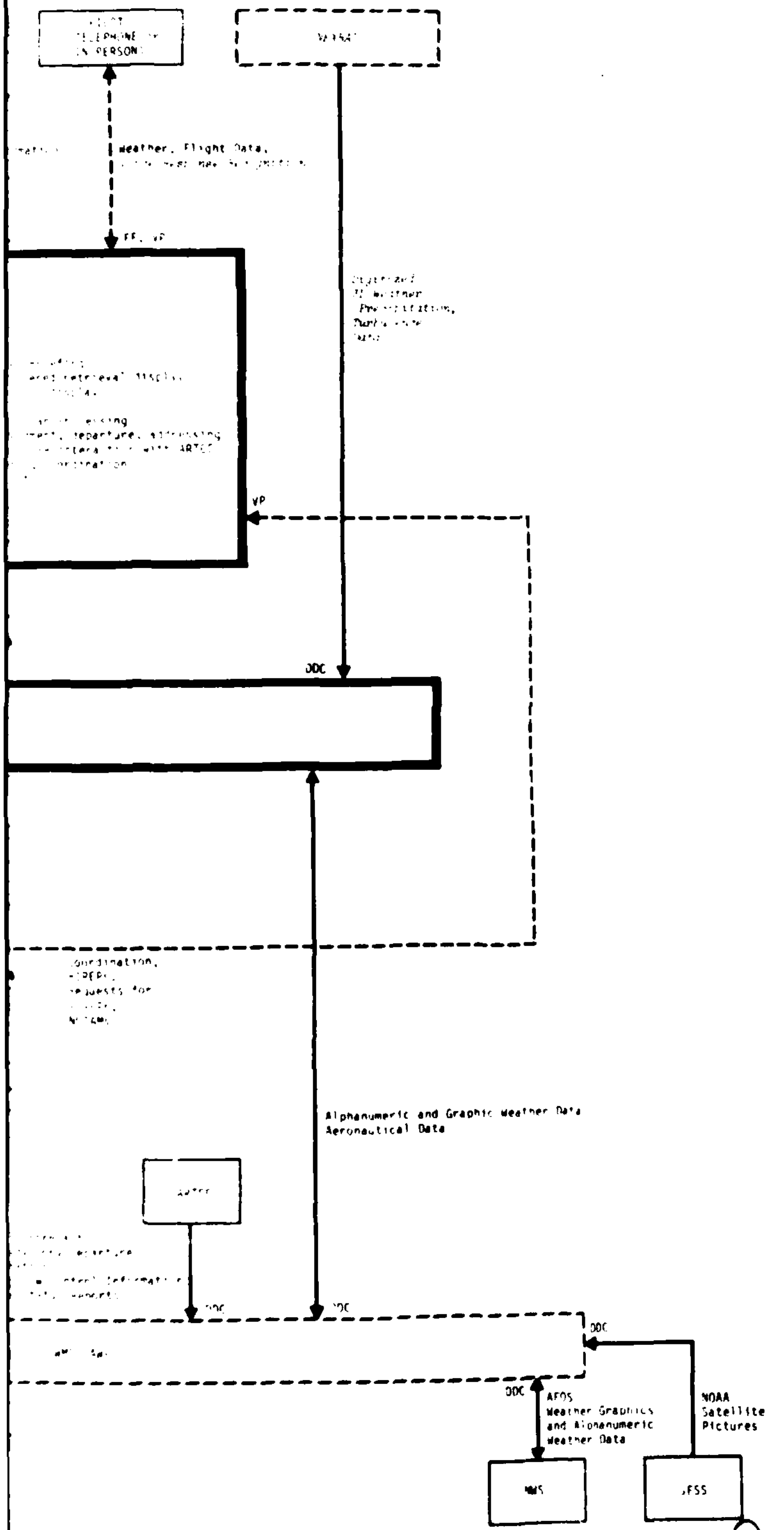


FIGURE 6-13
FAR TERM FLIGHT SERVICE CONNECTIVITY DIAGRAM

A/N weather and aeronautical data to and from the FSDPSs. In the Near Term Model 2 system, the data will be transmitted to and from the AWP via NADIN Ia.

6.2.4 Aviation Weather Processor

The Aviation Weather Processor is introduced in the Near Term Model 2 system. Two AWPs will be provided, one at each NADIN switch location. The AWPs receive alphanumeric weather and aeronautical information from the WMSC and graphic weather from the NWS (i.e., AFOS products). They redistribute the weather and aeronautical information to the Flight Service Data Processing Systems after reformatting and expanding contractions for the alphanumeric data base to be used in pilot briefings. A plan to provide WMSC functions at the two AWP sites is being developed. The Far Term system shows the resultant configuration.

6.2.5 Air Traffic Control Command Center (ATCCC)

In the Current systems, ATCCC messages are received at the FSSs over the Service B (or ABDIS) network. In the Near Term Model 1, NADIN provides service to the FSDPSs (and FSSs). In Model 2 ATCCC information is sent to the AWP via NADIN for editing and retransmission to the Flight Service Data Processing System.

6.2.6 Air Route Traffic Control Center (ARTCC)

In the Current system, Service B is used to send IFR flight plans to departure ARTCCs and to send VFR flight plans to departure and destination Flight Service Stations. In the Near

Term and Far Term, NADIN communications will be utilized in a similar fashion. Requirements for support to the Center Weather Service Unit (CWSU) are being developed. If provided through an automated interface to the FSDPS/AWP such support will require additional functions and interfaces at Flight Service Facilities.

6.2.7 Pilot

The pilot and air crews are the users of the Flight Service Facilities. As such, information related to any of the functions described may be passed to the pilot in the form of weather briefings, flight plan handling and emergency services. In the Current and Near Term Model 1 systems, the pilot is connected to the Flight Service Station via telephone, radio or face-to-face contact. In Model 2, the pilot is able to use the system directly by means of user terminals in addition to the support from the Flight Service Specialist. Also, the pilot is a source of information about current weather conditions which enter the system as PIREPs. In the Far Term, additional direct support to the pilot is provided by the Integrated Voice Response Systems and the utilization of Voice Recognition capabilities.

6.2.8 Tower Cab

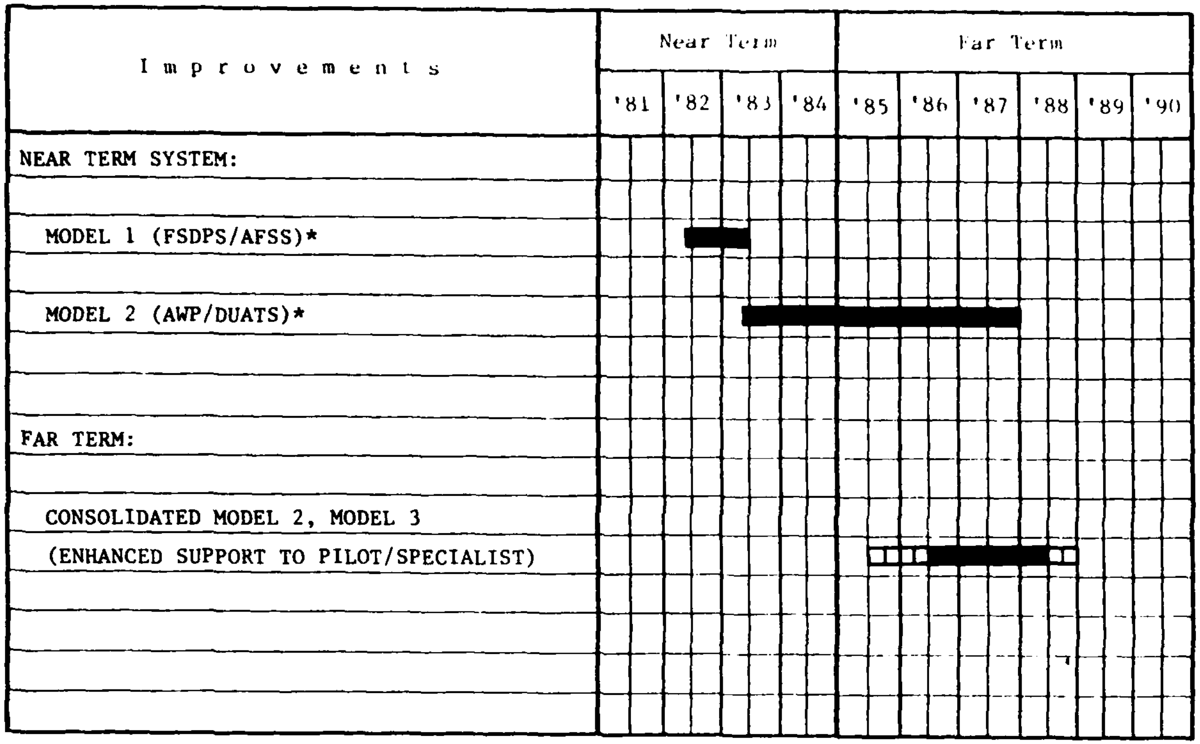
Throughout the time periods covered in this report, there is a voice connection between the Flight Service Station system and the Tower Cab for the exchange of information on airport conditions and local weather condition and forecasts.

6.2.9 Weather Radar Surveillance Site

In the Current system, weather radar images are available in a limited number of FSSs. In the Near Term Model 1 time period, digitized weather radar will be available at the 44 En Route Flight Advisory Service (EFAS) positions from either selected FAA ARSR radars or from NWS WSR-57 radars. For Model 2, digital weather radar from up to 13 radars will be available from Remote Radar Weather Display Subsystem digitizers. This will be displayed to the specialist by request. Each FSDPS will store a weather radar image for all digitizer-equipped radars (with a maximum of 13) within the FSDPS boundaries plus 150 nautical miles. In the Far Term, the Next Generation Weather Radar (NEXRAD) program is expected to result in new improved weather capabilities.

6.3 Flight Service Facilities Tentative Implementation Schedule

Figure 6-14 shows a tentative implementation schedule derived from Reference 6-1, 6-2 and other sources. The completion of proposal requests, governmental reivew processes, and the negotiation of contracts to develop and implement the required capabilities may modify these schedules. The Near Term system, Model 1, begins the process of automating Flight Service Stations with emphasis on automated support to the specialist both for the entry and retrieval of information and for automated data base maintenance. In Model 2 and Model 3, automation of specialist support is extended by the provision of more extensive and selective retrieval capabilities, improved graphics and improved displays and terminals. Direct support to the pilot provides for access to the system utilizing the Direct User Access Terminal (DUAT) or via telephone to the Voice



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 6-14
FLIGHT SERVICE FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE

Response System (VRS). The analysis and development of Voice Response capabilities and Voice Recognition features is proceeding independent of specific automation models, e.g., Voice Response capabilities are being developed for separate implementation as soon as possible. Possible changes in or extensions to schedules are indicated by the broken bars. Data base maintenance is further automated in the Model 2 with the provision of the Aviation Weather Processors (AWPs) which also develop the pilot oriented data base in which weather and aeronautical messages are reformatted and contractions are expanded for improved understandabiliy. For the Near Term system, some 14 FSDPSs will be installed and will support a total number of AFSSs expected to be 41. These installations will cover a period of months. Similarly, Model 2 installation, well underway in the near term, is not completed until the far term with the consolidation of all FSSs into 61 AFSSs and 23 FSDPSs requiring the upgrading of hardware in the existing Model 1 FSDPSs and 9 new installations. It is anticipated that once Model 2 has been completely installed, Model 3 enhancements can be released as they become available.

6.4 Flight Service Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a Flight Service Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issues cited below were identified during the preparation of this document and were reviewed with the appropriate FAA program managers. Follow-up on these issues was undertaken by a joint System Research and Development Service and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in early December 1980. The Reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions. The integration issue assumptions pertinent to Flight Service facilities are:

Issue 602: AWP-WMSC Combined Function

This presentation of Flight Service Facilities assumes that a consolidated facility to perform combined AWP-WMSC functions will be implemented in the Far Term. Such a plan is being considered by AAF-400. The current Flight Service Automation System program for implementing Model II does not, however, include the combined AWP-WMSC function nor does NADIN planning.

Issue 604: VSCS Support to AFSSs

The assumption is that VSCS will provide voice communications (radio and ground/ground) for the proposed 61 consolidated AFSSs, however, the VSCS program is proceeding slowly with the FSS portion currently scheduled for the second Technical Data Package. The problem is further complicated by the uncertainty about the amount and kind of consolidation to be carried out for the AFSSs, and the time phasing of the consolidations. VSCS contract award is planned in early 1982 with late 1983

delivery. Since the AFSS schedule precedes this schedule, interim communications must be provided for the first 12 to 15 AFSSs. VSCS will be implemented in these sites following the implementation of the other AFSSs.

Issue 605: FSS-DABS Data Link Utilization

It is assumed that no capability for pilot utilization of DABS data link to the FSDPS/AFSS will be implemented in the foreseeable future. The utilization of Data Link for automated communications between aircraft and FSDPS/AFSS may be desireable (e.g. Flight Plan filing, flight following, weather data base access). Specific requirements and how they might be satisfied are undefined. Cost/benefit analysis of possible capabilities have not been done.

Issue 606: Voice communications Equipment for Non-Automated FSSs

The VSCS program, as presently structured, will not provide radio or ground/ground voice communications equipment for the non-automated FSSs. It is assumed that, in accordance with the VSCS specification, VSCS will provide non-automated FSSs the capability to remote both existing radio and ground/ground voice communications facilities back to an associated AFSS and allow part-timing operation at the non-automated FSS.

Issue 607: Part-Time Use of Non-Automated FSSs

The current VSCS specification requires and this description of Voice Communications Facilities assumes that both radio and ground/ground voice communications equipment and support will be

provided to AFSSs to permit part-time operation of non-automated FSSs. However, operators of the Flight Service Stations have expresses reservations with regard to the projected cost savings which may be achieved from part-timing.

7. SURVEILLANCE FACILITIES

This chapter describes the system improvements planned for the Surveillance Facilities and the interfaces with other ATC facilities for Current, Near Term and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1. The description in this chapter include the facilities that provide surveillance information on aircraft and the weather for use by the en route and terminal ATC facilities. The use of search radars (ASRs, ARSRs) and beacon systems (ATCRBS, DABS) to provide surveillance information is discussed as well as surveillance data preprocessing performed at the surveillance sites. In addition, the utilization of separate three dimensional weather radars to provide weather data is discussed. And since the Automatic Traffic Advisory and Resolution Service (ATARS), the DABS Data Link and the Beacon Collision Avoidance System (BCAS) have elements associated with the ground surveillance sites, they are also discussed in this chapter.

First, the anticipated Near Term and Far Term improvements for the en route surveillance sites are described in Section 7.1. Then, a similar description of terminal surveillance site improvements is presented in Section 7.2. This, in turn, is followed in Section 7.3 by a summary of the major assumptions that were made with regard to Surveillance Facilities.

See Chapter 4, Tower Facilities, for a discussion of Airport Surface Detection Equipment (ASDE). ASDE is a surface search radar that is used to locate aircraft on an airport's surface when the visibility conditions are poor.

7.1 En Route Surveillance Sites

This section briefly summarizes the functions currently performed at a typical en route surveillance site, describes the anticipated Near Term and Far Term improvements, and briefly discusses the tentative time phasing of these improvements.

7.1.1 Current En Route Surveillance Site Functions

Table 7-1 lists the major functions currently performed at a typical en route surveillance site. The en route search radar, also referred to as a Long Range Radar (LRR) or as an Air Route Surveillance Radar (ARSR), depends solely upon electromagnetic reflections for its surveillance information. Each ARSR has a directional antenna which rotates 360° every 10 to 12 seconds while the ARSR transmits a stream of L band pulses and detects and processes the L band returns. Included in this processing is the utilization of Moving Target Indicator (MTI) circuitry to detect moving targets and suppress background clutter due to electromagnetic reflections from the surrounding terrain.

The Beacon Interrogator, also referred to as an Air Traffic Control Beacon Interrogator or ATCBI, has a directional antenna which rotates with the ARSR antenna on the same pedestal. The ATCBI interrogates an aircraft's ATCRBS transponder to obtain azimuth, range, altitude and identity information from the transponder's reply.

TABLE 7-1
CURRENT EN ROUTE SURVEILLANCE SITE
FUNCTIONS AND EQUIPMENT

Functions	Equipment	
1. Search Radar		
• Pulse transmission	L-band transmitter	ARSR
• Target detection and the suppression of clutter	L-band receiver, Moving Target Indicator (MTI)	ARSR
2. Beacon		
• ATCRBS interrogations	ATCRBS transmitters	ATCBI
• Reply detection	ATCRBS receiver	ATCBI
3. Surveillance Data Preprocessing		
• *Target data quantization and the merger of* search radar and beacon interrogator data	Common Digitizer (CD)	
• Weather (precipitation) quantization	Weather Fixed Map Unit (WFMU)	

Surveillance data preprocessing is performed by the Common Digitizer (CD) which:

- Converts the broadband (video) surveillance information from the ARSR and the ATCBI into digital data;
- Combines the numerous replies received from each aircraft during a single antenna scan; and
- Merges the combined ARSR search data on each aircraft with the combined ATCBI data to produce a single target report (range, azimuth, altitude and identity) on each aircraft for each antenna scan.

The Weather Fixed Map Unit (WFMU) converts the broadband ARSR weather (precipitation) information into digital data defining two precipitation levels (low and high). The digitized aircraft target reports and the weather data are combined in the CD and sent to the ARTCC over telephone lines as narrowband (digital) data. As a backup, broadband (video) data is sent over a Radar Microwave Link (RML) to the ARTCC.

7.1.2 Near Term En Route Surveillance Site Improvements

As shown in Table 7-2 and Figures 7-1, 7-2 and 7-3, two significant improvements are anticipated in the Near Term.

Dual Common Digitizer (CD-2)

The Common Digitizer will be replaced with a Dual Common Digitizer (CD-2) to improve site reliability, since the CD is

TABLE 7-2
EN ROUTE SURVEILLANCE SITE
IMPROVEMENTS SUMMARY

Functions	Current System (1980)	Near Term Improvements (1981-1984)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
1. Search Radar				
• Target detection and the suppression of clutter	MTI	NC	MTD	
• Weather detection	NWS Weather Radar	NC	NEXRAD, ARSR Weather Channel	
• Equipment reliability and maintainability	ARSR -1, -2, -3	NC	ARSR -4, RMMS	
2. Beacon Interrogator				
• Interrogation	ATCRBS transmitter	NC	NC	DABS transmitter
• Reply detection	ATCRBS receiver	NC	NC	DABS receiver
• Ground to air to ground digital data link	NA	NA	NC	DABS data link
• Equipment reliability and maintainability	ATCBI -3, -4, -5	NC	NC	DABS, RMMS
3. Surveillance Preprocessing				
• Target data quantization and the merger of search radar and beacon interrogator data	Common Digitizer	CD-2*	NC	DABS processor
• Weather data quantization	WFMU	CD-2*	Automatic detection of turbulence (NEXRAD)	
4. Collision Avoidance Systems	NA	BCAS	NC	ATARS

ABBREVIATIONS

*	Approved by the FAA for implementation	MTD	Moving Target Detector
ARSR	Air Route Surveillance Radar	MTI	Moving Target Indicator
ATARS	Automated Traffic Advisory and Resolution Service	NA	Not Applicable
ATCBI	Air Traffic Control Beacon Interrogator	NC	No change included in present plans
ATCRBS	Air Traffic Control Radar Beacon System	NEXRAD	Next Generation Weather Radar
BCAS	Beacon Collision Avoidance System	NWS	National Weather Service
CD	Common Digitizer	RMMS	Remote Maintenance Monitor System
DABS	Discrete Address Beacon System	WFMU	Weather and Fixed Map Unit

INPUTS

From Aircraft

- Search Radar Returns
- ATCRBS Replies

From Precipitation

- Search Radar Returns

Current En Route Surveillance Site

FUNCTIONS

1. Search Radar
   - Pulse Transmission
   - Target Detection and the Suppression of Clutter
   - Weather Detection
2. Beacon Interrogator
   - ATCRBS Interrogations
   - Reply Detection
3. Surveillance Data Preprocessing
   - Target Data Quantization and the Merger of Search Radar and Beacon Interrogator Data
   - Weather (Precipitation) Data Quantization

OUTPUTS

To Aircraft

- Search Radar Transmissions
- ATCBI Interrogations

To Precipitation

- Search Radar Transmissions

To ARTCC

-Search Radar

- Digitized Aircraft Target Reports (Range, Azimuth)
- Digitized 2D Weather Data
- Broadband (Video) Aircraft and 2D Weather Returns (Range, Azimuth)

-ATCRBS

- Digitized Aircraft Target Reports (Range, Azimuth, Identity and Altitude)
- Broadband Aircraft Target Reports

To FSS

-Search Radar

- Digitized 2D Weather Data

FIGURE 7-1
CURRENT EN ROUTE SURVEILLANCE SITE FACILITIES
INFORMATION FLOW DIAGRAM

INPUTS	FUNCTIONS	OUTPUTS
	Near Term En Route Surveillance Site	

INPUTS

From Aircraft

- Search Radar Returns
- ATCRBS Replies

From Precipitation

- Search Radar Returns

Near Term En Route Surveillance Site

FUNCTIONS

1. Search Radar
   - Pulse Transmission
   - Target Detection and the Suppression of Clutter
   - Weather Detection
2. Beacon Interrogator
   - ATCRBS Interrogations
   - Reply Detection
3. Surveillance Data Preprocessing
   - Target Data Quantization and the Merger of Search Radar and Beacon Interrogator Data (CD-2)
   - Weather (Precipitation) Data Quantization (CD-2)

OUTPUTS

To Aircraft

- Search Radar Transmissions
- ATCBI Interrogations

To Precipitation

- Search Radar Transmissions

To ARTCC

-Search Radar
- Digitized Aircraft Target Reports (Range, Azimuth)
- Digitized 2D Weather Data

-ATCRBS
- Digitized Aircraft Target Reports (Range, Azimuth Identity, and Altitude)

To FSS or FSDPS

-Search Radar
- Digitized 2D Weather Data

Note: *Changes from the Current System to the Near Term indicated by underlining*

FIGURE 7-2
NEAR TERM EN ROUTE SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM

INPUTS

From Aircraft

- Search Radar Returns
- ATCRBS Replies

From Precipitation

- Search Radar Returns

Far Term En Route Surveillance Site

FUNCTIONS

1. Search Radar
   - Pulse Transmission
   - Target Detection and the Suppression of Clutter (MTD)
   - Weather Detection (ARSR Weather Channel)
   - Remote Maintenance Monitoring (RMMS)
2. Beacon Interrogator
   - ATCRBS Interrogations
   - ATCRBS Reply Detection
3. Surveillance Data Preprocessing
   - Target Data Quantization and the Merger of Search Radar and Beacon Interrogator Data (CD-2)
   - Weather (Precipitation) Data Quantization (CD-2)

OUTPUTS

To Aircraft

- Search Radar Transmissions
- ATCRBS Interrogations

To Precipitation

- Search Radar Transmissions

To ARTCC

-Search Radar
- Digitized Aircraft Target Reports (Range, Azimuth)
- Digitized 2D Weather Data

-ATCRBS
- Digitized ATCRBS Aircraft Target Reports (Range, Azimuth, Identity and Altitude)

Note: Changes from the Near Term to the Far Term are indicated by underlining

FIGURE 7-3
FAR TERM EN ROUTE SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM

not redundant at the present time. This change will also permit the replacement of the WFMU with circuitry within the CD-2 to improve the accuracy of the digitized weather data by correcting for range in the weather calibration based on the Sensitivity Time Control (STC) curves. The weather data will be forwarded to the ARTCCs and some FSSs or AFSSs.

Beacon Collision Avoidance System (BCAS)

Another Near Term improvement that is indirectly related to Surveillance Facilities is BCAS, which will interface with other potential surveillance improvements such as DABS and ATARS. BCAS is an airborne collision avoidance system that interrogates ATCRBS and DABS transponders in the vicinity of the BCAS-equipped aircraft. If the BCAS system determines that there is a potential conflict with another aircraft, it will alert the pilot to the hazardous situation. See Chapter 3 for a more detailed discussion of BCAS.

7.1.3 Far Term En Route Surveillance Site Improvements

In the Far Term, five significant improvements are tentatively being considered by the FAA.

Moving Target Detector (MTD)

The FAA is considering the replacement of existing MTI circuitry with an MTD (Reference 7-1) on all ARSR-3s in order to improve the detection of aircraft in the presence of clutter. This, in turn, would improve the quality of the surveillance data sent to the associated ARTCCs.

In addition to suppressing clutter due to terrain, which is also suppressed by the MTI, the MTD would also suppress clutter due to the weather. It is estimated that the MTD would provide approximately a 20 dB improvement in the detection of aircraft in heavy clutter in comparison with an MTI. This improvement is important not only for tracking aircraft that are unequipped with an ATCRBS transponder, but also for tracking aircraft with transponders that are temporarily not replying to beacon interrogations, e.g., due to aircraft shielding while the aircraft are turning.

The MTD would also be capable of detecting aircraft at or near zero radial velocity, when they are flying perpendicular to the radar line of sight.

ARSR-4

The FAA is considering replacing vacuum tube ARSR -1s, -2s with solid state ARSR-4s and thereby improving equipment reliability and maintainability. The planned ARSR-4 design includes RMM, a separate weather channel, and MTD instead of MTI.

ARSR Weather Channel

ARSRs are currently optimized for target detection through the use of circular polarization and the selection of the appropriate STC curve. These techniques minimize the capability to detect weather. In order to provide improved weather information, the FAA is considering the use of a second ARSR L band receiver channel on ARSR-3s and -4s to optimize the detection of precipitation by using linear polarization and

selecting a STC that is more appropriate for weather detection. The detected precipitation information would be quantized by the MTD and the resultant digital data sent to the associated ARTCC and FSS or Flight Service Data Processing System (FSDPS). In addition to improved detection of aircraft in heavy clutter, one of the attributes of the MTD is the ability to separate ground clutter from weather clutter, thus, providing improved weather data from the weather receiver.

Next Generation Weather Radar (NEXRAD)

At the present time, a network of 80 radars located across the conterminous United States is used to provide weather information to the National Weather Service (NWS).

56	National Weather Service (NWS) weather radars
2	USAF Air Weather Service (AWS) weather radars
22	FAA ARSRs
80	

The NWS weather radars cover the U.S. east of the Rocky Mountains and at scattered locations in the West. The ARSRs that provide weather information to NWS are located in the West. Digitized 2D weather information is currently being sent from the NWS weather radars to nearby ARTCCs and some FSSs. The useful range of each NWS weather radar for ATC use is about 125 nm. Beyond that, the curvature of the earth prevents good low altitude coverage. In addition to the weather radars in the network, 65 NWS weather radars and 84 DOD weather radars are being used to provide local weather information.

Due to their age, the NWS and AWS are planning to replace the network weather radars and some of the local weather radars with NEXRADs during the 1980s (Reference 7-2). The ARSRs would be used to supplement NEXRAD as far as network weather information is concerned.

NEXRAD would probably utilize a pencil beam antenna to obtain three-dimensional weather (precipitation) information, and digital doppler processing to automatically detect turbulence and forecast its movement 10 to 20 minutes into the future. Only turbulence associated with precipitation may be detected - clear air turbulence would not.

Remote Maintenance Monitor System (RMMS)

RMMS will be installed at each site to monitor the performance of the site equipment and to forward this information to the associated ARTCC (see Chapter 2 for a discussion of RMMS).

7.1.4 Potential and Longer Range Improvements for En Route Surveillance Sites

Beyond these anticipated Far Term improvements, the FAA is tentatively exploring the use of the Discrete Address Beacon System (DABS) and the Automatic Traffic Advisory and Resolution Service (ATARS) at en route surveillance sites. Both DABS and ATARS are discussed in Section 7.2.3.

7.1.5 En Route Surveillance Site System Connectivity

Connectivity diagrams specify the kinds of messages sent between

ATC facilities, and the communications media used (e.g., directly wired, digital data channel, teletypewriter channel, etc.) Figures 7-4, 7-5, and 7-6 illustrate the current connections between an en route surveillance site and other ATC facilities, and the anticipated changes in these connections due to the Near Term and Far Term improvements.

There are no significant changes in connectivity in the Near Term. In the Far Term, two changes may be made:

- After the CD-2s are installed at the en route surveillance sites and the Direct Access Radar Channels (DARCs) are installed at the ARTCCs, the backup broadband surveillance data may be eliminated, if the digital weather data is considered to be acceptable.

- A separate NEXRAD radar network might replace the ARSRs as the primary source of weather surveillance data for the ARTCCs.

7.1.6 En Route Surveillance Improvements Tentative Implementation Schedule

A tentative implementation schedule for the en route surveillance improvements is given in Figure 7-7. It should be emphasized that this schedule may change in the future depending upon the need and progress of the individual improvements.

Implementation information on some of these improvements was obtained from preliminary budgetary information. Information on the remaining improvements is based upon discussions with the

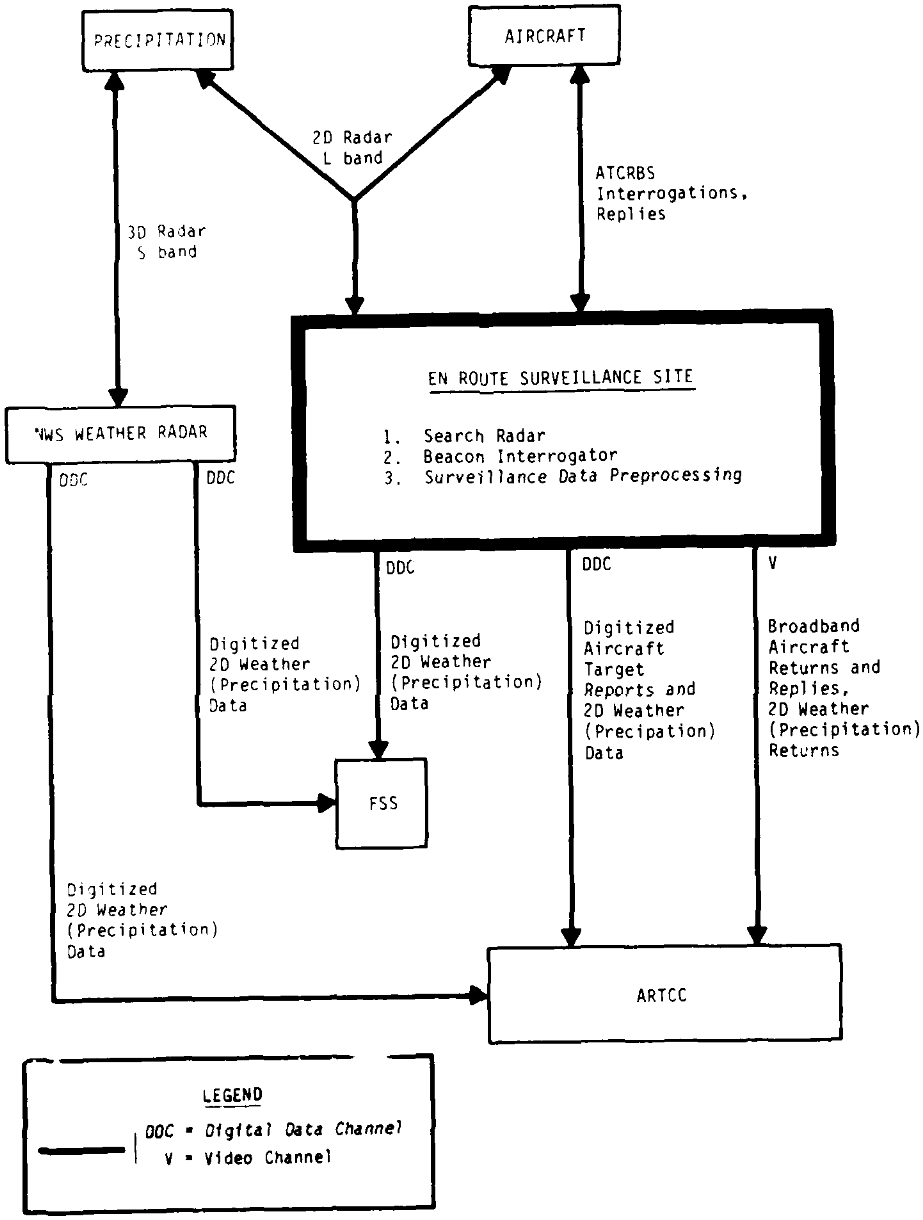
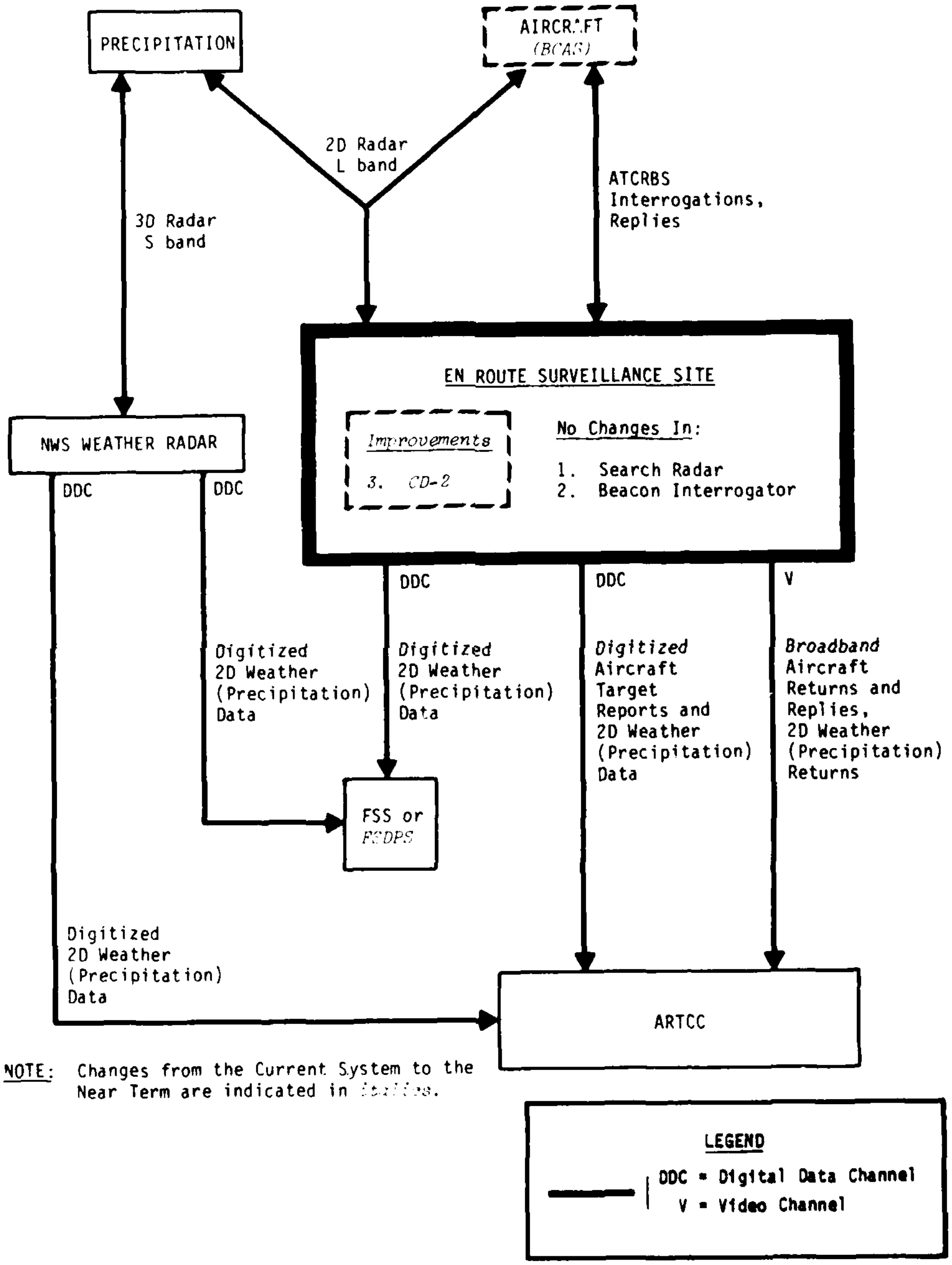
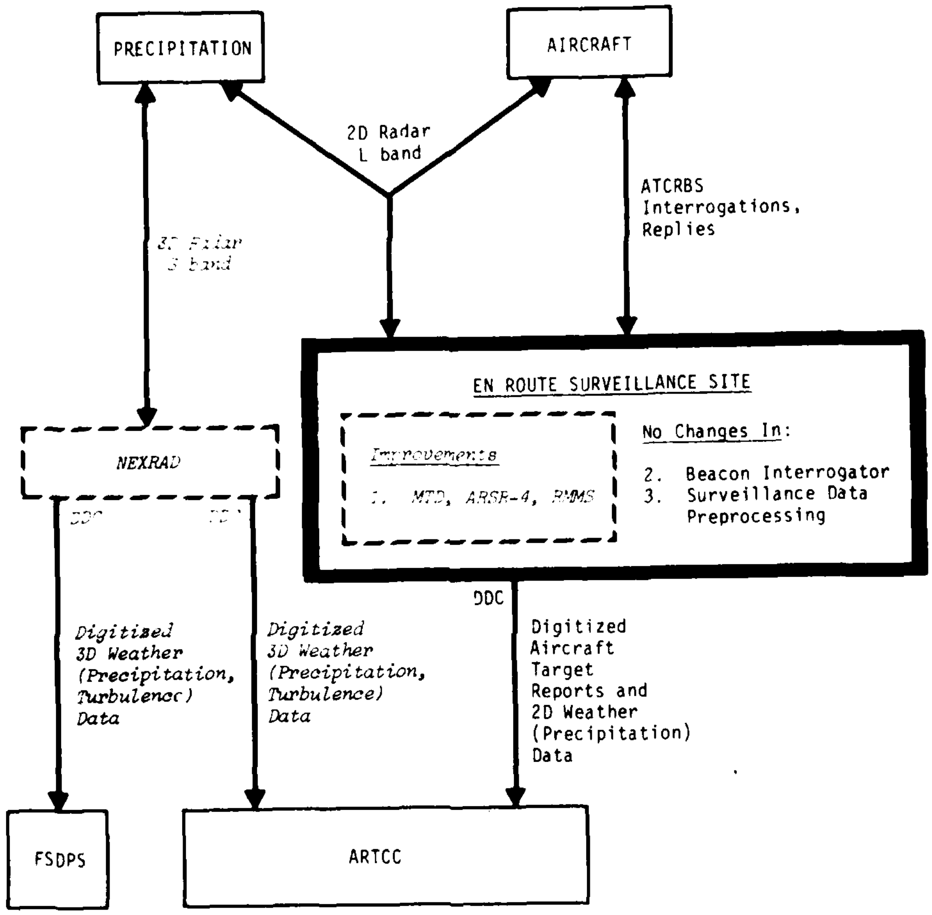


FIGURE 7-4
CURRENT EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM



NOTE: Changes from the Current System to the Near Term are indicated in *italics*.

FIGURE 7-5
NEAR TERM EN ROUTE SURVEILLANCE SITE CONNECTIVITY DIAGRAM

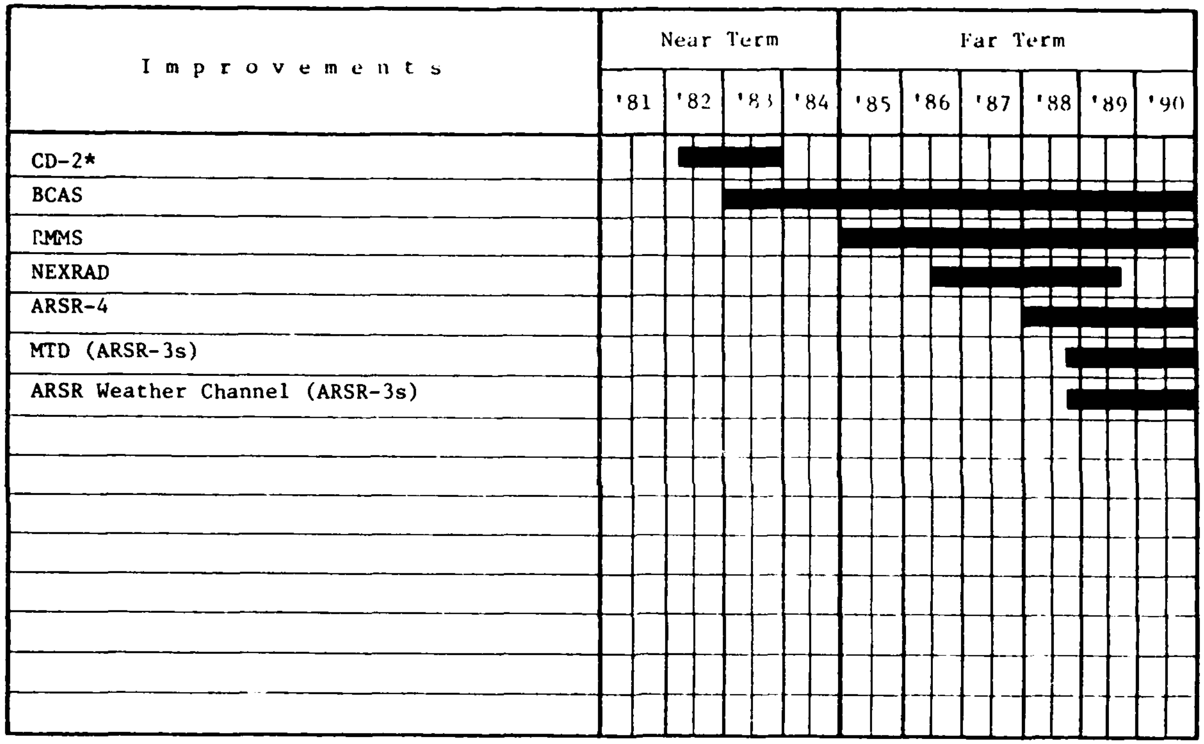


NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

LEGEND

DDC = Digital Data Channel

FIGURE 7-6
FAR TERM EN ROUTE SURVEILLANCE SITE
CONNECTIVITY DIAGRAM



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

FIGURE 7-7
EN ROUTE SURVEILLANCE FACILITIES
TENTATIVE IMPLEMENTATION SCHEDULE

FAA program managers involved with these projects. At the present time, the only firm implementation plans for any of the anticipated en route surveillance improvements are those for the Dual Common Digitizer (CD-2).

7.2 Terminal Surveillance Sites

This section briefly summarizes the functions currently performed at a typical terminal surveillance site and the anticipated Near Term and Far Term improvements. Where there is a similarity between the en route and terminal surveillance site improvements, a less detailed description of the terminal site improvements is presented.

7.2.1 Current Terminal Surveillance Site Functions

Table 7-3 lists the major functions currently performed at a terminal surveillance site. The Search Radar, also referred to as an Airport Surveillance Radar or ASR, depends solely upon electromagnetic reflections for its surveillance information. Each ASR has a directional antenna which rotates 360^{o} every 4 to 5 seconds while the ASR transmits a stream of S band pulses and detects the S band returns. Included is the utilization of MTI circuitry to detect moving targets and suppress background clutter due to electromagnetic reflections from the surrounding terrain. The resultant video is sent to the associated TRACON or TRACAB.

The Beacon Interrogator (ATCBI) has a directional antenna which rotates with the ASR's antenna on the same pedestal. The ATCBI interrogates an aircraft's ATCRBS transponder and forwards the

TABLE 7-3
CURRENT TERMINAL SURVEILLANCE SITE
FUNCTIONS AND EQUIPMENT

Functions	Equipment	
1. Search Radar		
• Pulse transmission	S-band transmitter	ASR
• Target detection and the suppression of clutter	S-band receiver, Moving Target Indicator (MTI)	
2. Beacon Interrogator		
• ATCRBS interrogations	ATCRBS transmitter	ATCBI
• Reply detection	ATCRBS receiver	
3. Defruiter	Defruiter	

transponder's reply to the TRACON or TRACAB as beacon video information. A Defruiter is used at the surveillance site to remove "fruit" from the reply, i.e., interference resulting from transponder replies to other beacon interrogators in the area. The defruited beacon video is also sent to the TRACON or TRACAB for further processing.

7.2.2 Near Term Terminal Surveillance Site Improvements

As shown in Table 7-4 and Figures 7-8, 7-9, and 7-10, two significant improvements are anticipated in the Near Term at terminal surveillance sites associated with ARTS IIIA TRACONs. It has been assumed in this report that these improvements will also be made at ARTS II terminal surveillance sites eventually.

Beacon Collision Avoidance System (BCAS)

This improvement has previously been described in Section 7.1.2 and Chapter 2.

Radar Beacon Transponder (RBX)

RBXs will be used at some airports to desensitize BCAS systems in the vicinity of the airport as a function of distance and altitude. The closer the BCAS-equipped aircraft is to the runway, the greater the desensitization will be. The TRACON will be able to change the desensitization parameters by sending commands to the RBX.

In addition to desensitizing the aircraft, the RBX will also forward to the TRACON any BCAS advisories issued to a pilot. If

TABLE 7-4
TERMINAL SURVEILLANCE SITE
IMPROVEMENTS SUMMARY

Functions	Current System (1980)	Near Term Improvements (1981-1984)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
1. Search Radar				
• Target detection and the suppression of clutter	MTI	NC	MTD	LSR
• Weather detection	NA	NA	NEXRAD, ASR Weather Channel	FAA Terminal Weather Radar
• Equipment reliability and maintainability	ASR -4, -5, -6, -7, -8	NC	ASR -9, RMMS	
2. Beacon Interrogator				
• Interrogation	ATCRBS transmitter	NC	DABS transmitter	
• Reply detection	ATCRBS receiver	NC	DABS receiver	
• Ground to air to ground digital data link	NA	NC	DABS	
• Equipment reliability and maintainability	ATCBI -3, -4, -5	NC	DABS, RMMS	
3. Defruiter	Defruiter	NC	DABS processor	
4. Surveillance Data Preprocessing				
• Target data quantization, and the merger and correlation of search radar and beacon interrogator data	NA	NC	DABS processor	
• Weather data quantization	NA	NA	Automatic detection of turbulence, wind shear (NEXRAD)	FAA Terminal Weather Radar
5. Collision Avoidance Systems	NA	BCAS, RBX	ATARS	

ABBREVIATIONS

ASR	Airport Surveillance Radar	MTD	Moving Target Detector
ATARS	Automated Traffic Advisory and Resolution Service	MTI	Moving Target Indicator
ATCBI	Air Traffic Control Beacon Interrogator	NA	Not Applicable
ATCRBS	Air Traffic Control Radar Beacon System	NC	No Change Included in Current Plans
BCAS	Beacon Collision Avoidance System	NEXRAD	Next Generation Weather Radar
DABS	Discrete Address Beacon System	RBX	Radar Beacon Transponder
LSR	Limited Surveillance Radar	RMMS	Remote Maintenance Monitor System

IIIA primary airports, including the possible detection of wind shear along the approach path, if the wind shear is associated with precipitation. The information would also be sent to the Tower Cab where it would be used by the air traffic controllers to alert the pilots attempting to land at the airport.

Discrete Address Beacon System (DABS)

DABS would further improve the beacon system beyond the capabilities of ATCRBS by allowing a beacon interrogator to discretely address aircraft equipped with a DABS transponder, and by using monopulse techniques to reduce the number of beacon interrogations per scan (Reference 7-3). These improvements, in turn, would permit an increase in beacon surveillance capacity and reduce interference.

The fundamental difference between ATCRBS and DABS is the manner of selecting which aircraft responds to an interrogation. ATCRBS interrogates all aircraft within coverage of the main beam of the beacon interrogator's directional antenna, while DABS interrogates each aircraft individually. After acquisition, selection of which aircraft responds to a DABS interrogation would be accomplished by including the aircraft's address in the interrogation. Directional antennas would continue to be used by the DABS interrogators in order to minimize interference between DABS sites and to determine the aircraft's azimuth. The discrete address capability of DABS would also provide the means for a ground to air to ground digital data link.

Since the implementation of DABS ground sites and the

INPUTS

From Aircraft

- Search Radar Returns
- ATCRBS Replies

From Precipitation

- Search Radar Returns

Near Term Terminal Surveillance Site

FUNCTIONS

1. Search Radar
   - Pulse Transmission
   - Target Detecton and the Suppression of Clutter
   - Weather Detection
2. Beacon Interrogator
   - ATCRBS Interrogations
   - Reply Detection
3. Defruiter

OUTPUTS

To Aircraft

- Search Radar Transmissions
- ATCBI Interrogations

To Precipitation

- Search Radar Transmissions

To ARTS IIIA TRACON

-Search Radar
- Broadband (Video) Aircraft and 2D Weather Returns (Range, Azimuth)

-ATCRBS
- Broadband (Video) Aircraft Replies (Range, Azimuth, Altitude and Identity)

Note: Changes from the Current System to the Near Term are indicated by underlining.

FIGURE 7-9
NEAR TERM TERMINAL SURVEILLANCE SITE FACILITIES INFORMATION FLOW DIAGRAM

Far Term Terminal Surveillance Site

INPUTS

From Aircraft

- Search Radar Returns
- ATCRBS, DABS Replies
- BCAS Advisories

From Precipitation

- Search Radar Returns

From ARTS IIIA TRACON

- Altimeter Correction
- ETIS Messages
- Aircraft Control State Messages

From Adjacent DABS Site

- DABS, ATARS Coordination Messages

From ARTCC

- Aircraft Control State Message

FUNCTIONS

1. Search Radar
   - Pulse Transmission
   - Target Detection and the Suppression of Clutter
   - Weather Detection (ASR Weather Channel)
2. Beacon Interrogator

   Precipitation

   - ATCRBS, DABS Interrogators
   - ATCRBS, DABS Reply Detection
3. Defruiter (DABS)
4. Surveillance Data Preprocessing
   - Target Data Quantization, and the Merger and Correlation of Search Radar and Beacon Interrogator Data (DABS)
   - Weather (Precipitation) Data Quantization (MTD)
5. ATARS
   - ATARS Advisory Generation

OUTPUTS

To Aircraft

- Search Radar Transmissions
- ATCRBS, DABS Interrogations
- ETIS Messages
- ATARS Advisories
- BCAS Messages
- Altimeter Correction

To Precipitation

- Search Radar Transmissions

To Adjacent DABS Site

- DABS, ATARS Coordination Messages

To ARTS IIIA TRACON

-Search Radar
- Digitized Aircraft Target Reports (Range, Azimuth)
- Digitized 2D Weather Data

-DABS
- Digitized ATCRBS, DABS Aircraft Target Reports (Range, Azimuth, Altitude, and Identity)
- Controller Advisory (ATARS, BCAS) Messages
- Track Alert Messages

To ARTCC

- Digitized Aircraft Target Reports and 2D Weather Data
- Controller Advisory (ATARS, BCAS) Messages
- Track Alert Messages

Note: Changes from the Near Term to the Far Term are indicated by underlining

FIGURE 7-10
FAR TERM TERMINAL SURVEILLANCE SITE FACILITIES
INFORMATION FLOW DIAGRAM

a DABS/ATARS system is installed at the airport, the DABS will take over the RBX functions. (See 3.1.4.2 for a more complete description of RBX)

7.2.3 Far Term Terminal Surveillance Site Improvements

In the Far Term, seven significant improvements are tentatively being considered by the FAA.

Moving Target Detector (MTD)

The FAA is considering replacing the MTI circuitry in the ASR-7s, -8s with MTDs.

ASR-9

The FAA is considering replacing the vacuum tube ASR-4, -5, -6 with the solid state ASR-9 and thereby improving equipment reliability and maintainability. The ASR-9 would probably have MTD instead of MTI, and will include a separate weather channel.

ASR Weather Channel

This improvement would be similar to the ARSR Weather Channel, except that it would be an S band receiver instead of L band, and the information would be sent to a TRACON instead of an ARTCC.

Next Generation Weather Radar (NEXRAD)

The NEXRAD may provide terminal weather information at some ARTS

IIIA primary airports, including the possible detection of wind shear along the approach path, if the wind shear is associated with precipitation. The information would also be sent to the Tower Cab where it would be used by the air traffic controllers to alert the pilots attempting to land at the airport.

Discrete Address Beacon System (DABS)

DABS would further improve the beacon system beyond the capabilities of ATCRBS by allowing a beacon interrogator to discretely address aircraft equipped with a DABS transponder, and by using monopulse techniques to reduce the number of beacon interrogations per scan (Reference 7-3). These improvements, in turn, would permit an increase in beacon surveillance capacity and reduce interference.

The fundamental difference between ATCRBS and DABS is the manner of selecting which aircraft responds to an interrogation. ATCRBS interrogates all aircraft within coverage of the main beam of the beacon interrogator's directional antenna, while DABS interrogates each aircraft individually. After acquisition, selection of which aircraft responds to a DABS interrogation would be accomplished by including the aircraft's address in the interrogation. Directional antennas would continue to be used by the DABS interrogators in order to minimize interference between DABS sites and to determine the aircraft's azimuth. The discrete address capability of DABS would also provide the means for a ground to air to ground digital data link.

Since the implementation of DABS ground sites and the

installation of DABS transponders on aircraft would be expected to occur over a period of many years, the DABS equipment would be designed to be compatible with the existing ATCRBS equipment. Thus, DABS interrogators would be able to interrogate ATCRBS transponders, and DABS transponders would be able to respond to ATCRBS interrogators.

Due to the relatively early stage of DABS implementation planning at the present time, there are still an number of issues to be resolved. Therefore, for this description of the ATC system, the following assumptions have been made:

- The terminal surveillance sites with a DABS capability would have a range of 60 nautical miles and a scan rate of 4 to 5 seconds.
- The terminal surveillance sites with DABS would also have an ATARS capability.
- DABS and ATARS Coordination Messages would be sent to adjoining DABS sites. The DABS Coordination Messages would be used to coordinate coverage between adjacent sites. The ATARS Coordination Messages would be used to coordinate advisories to aircraft involved in conflicts near an ATARS boundary, and to initiate backup ATARS services to the extent possible from adjacent sites, when the primary ATARS site is not available.
- DABS surveillance data and ATARS controller advisory messages may be sent from the terminal surveillance sites to the associated ARTCCs at some locations.

AD-A103 241   MITRE CORP MCLEAN VA   F/G 1/2
FUTURE ATC SYSTEM DESCRIPTION ATC FACILITIES AND INTERFACES (19--ETC(U)
JAN 81   J H CHILDERS, R C HUNTER, D TUTTLE   DOT-FA01-81-C-10001
UNCLASSIFIED   MTR-81W6   FAA/RD-81/17   NL

4 OF 5
AD
A103241

Each DABS site would consist of: an ATCRBS/DABS Interrogator, an ATCRBS/DABS Monopulse Receiver, and a DABS Processor. The ATARS capability would be added by installing software in the DABS Processor.

The ATCRBS/DABS Interrogator would transmit ATCRBS and DABS interrogations to the aircraft, and the replies would be detected by the monopulse receiver. The DABS Processor would process these replies and estimate the location of each aircraft based upon a single transponder reply per scan for DABS and only four replies per scan for ATCRBS. Thus, the number of beacon transponder interrogations would be reduced in comparison with the current beacon system.

In addition, the DABS Processor would also: control the beacon interrogation modes of each site; control the data link message flow to and from the ATC facility and the aircraft; generate target reports (range, azimuth, altitude, and identity) on each aircraft for each antenna scan; correlate the target reports with reports from previous scans; and forward this surveillance data to the ATC facility.

Automatic Traffic Advisory and Resolution Service (ATARS)

As described in Chapters 2 and 3, the FAA has installed or is planning to install Conflict Alert software at the ARTCCs, and ARTS II, and ARTS III TRACONs. This software is used to advise the controller about potential conflicts, and thus prevent midair collisions involving aircraft that are: in radio contact with an air traffic controller, equipped with an altitude

reporting (Mode C) ATCRBS transponder, and within coverage of a beacon interrogator. The software processes the surveillance data and alerts the air traffic controller who, in turn, alerts the pilot.

As an eventual improvement to this service, the FAA may install ATARS software (Reference 7-3) at en route and terminal DABS sites. This software would automatically generate advisories to all pilots in aircraft equipped with a DABS transponder and an ATARS display (not just aircraft in contact with the ATC system). ATCRBS, DABS and ASR surveillance information would be used by the ATARS software to determine potential conflicts between aircraft. If a potential conflict was detected, then the DABS data link would be used to send the appropriate advisories to the pilot(s) to resolve the conflict.

ATARS is viewed as a service that would be provided in the later stages of an aircraft conflict and, thus, its warning times would be less than the warning times associated with the Conflict Alert algorithms. Since the maneuvers of aircraft responding to ATARS advisories might disrupt the orderly flow of IFR traffic, the ATARS messages would also be sent to the associated ARTCC or ARTS II or IIIA TRACON to inform the controllers.

Besides preventing potential midair collisions, ATARS would also be used to generate pilot advisories to avoid possible collisions with the terrain or obstacles, and violations of restricted airspace such as Terminal Control Areas.

Remote Maintenance Monitor System (RMMS)

RMMS will monitor the performance of the equipment at each terminal surveillance site and forward this information to the associated maintenance facility, which may not necessarily be located at a Tower Cab.

7.2.4 Potential and Longer Range Improvements for Terminal Surveillance Sites

Beyond these anticipated Far Term improvements, the FAA. is also tentatively exploring the use of Limited Surveillance Radars and Terminal Weather Radars as potential and longer range improvements. Limited Surveillance Radars (LSRs) are search radars that may be used at some airports that do not have an existing or planned ASR nearby, and that would not qualify for one. The LSRs would have less capability than an ASR, and a range of 20 nm. compared to 60 nm. for the ASR.

FAA Terminal Weather Radars may be used at some major airports if NEXRADs are not installed there. They would be used to provide local weather information for the TRACON and Tower Cab, including wind shear.

7.2.5 Terminal Surveillance Site System Connectivity

Figures 7-11, 7-12, and 7-13 illustrate the current connections between a terminal surveillance site and other ATC facilities and the changes in these connections due to the anticipated Near Term and Far Term improvements.

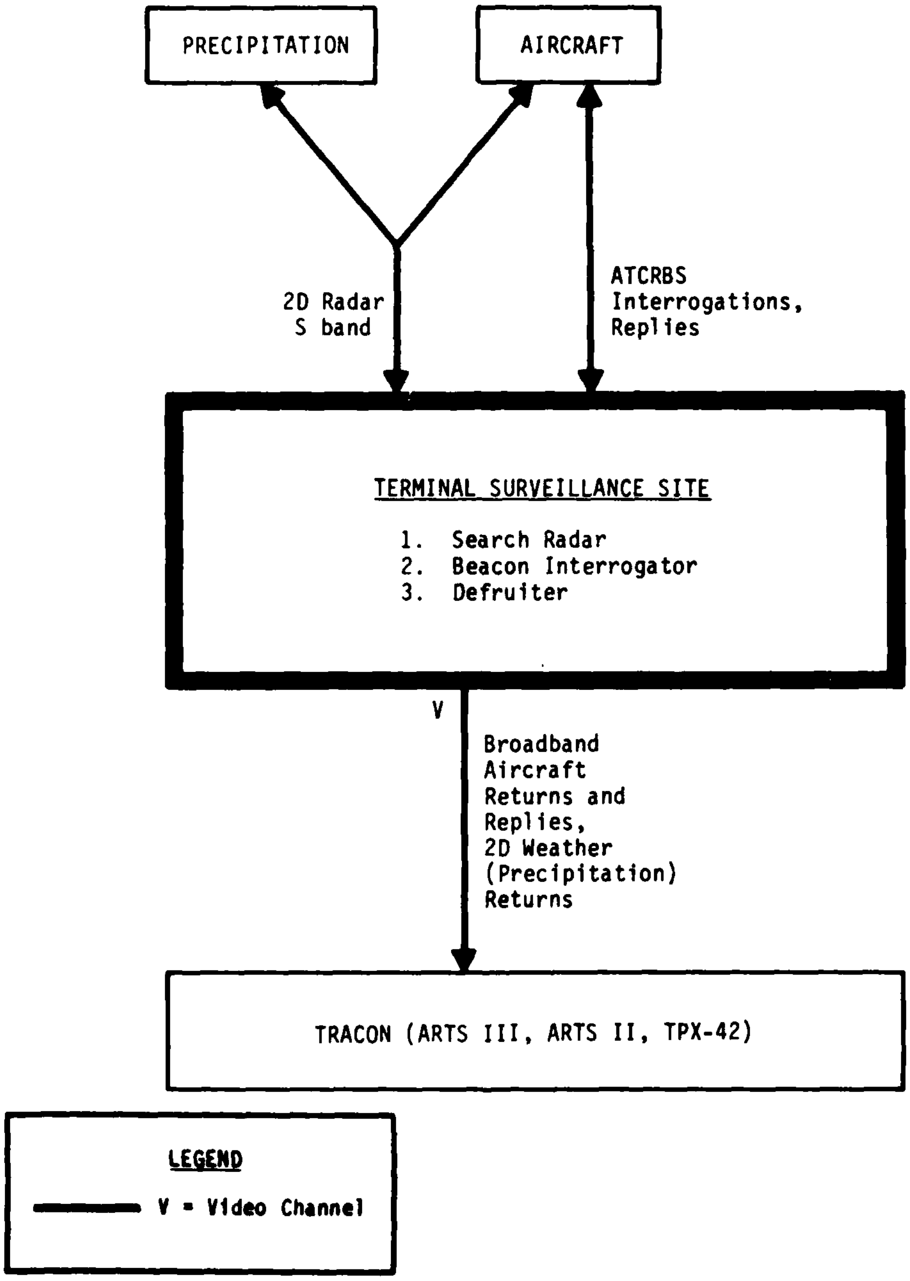
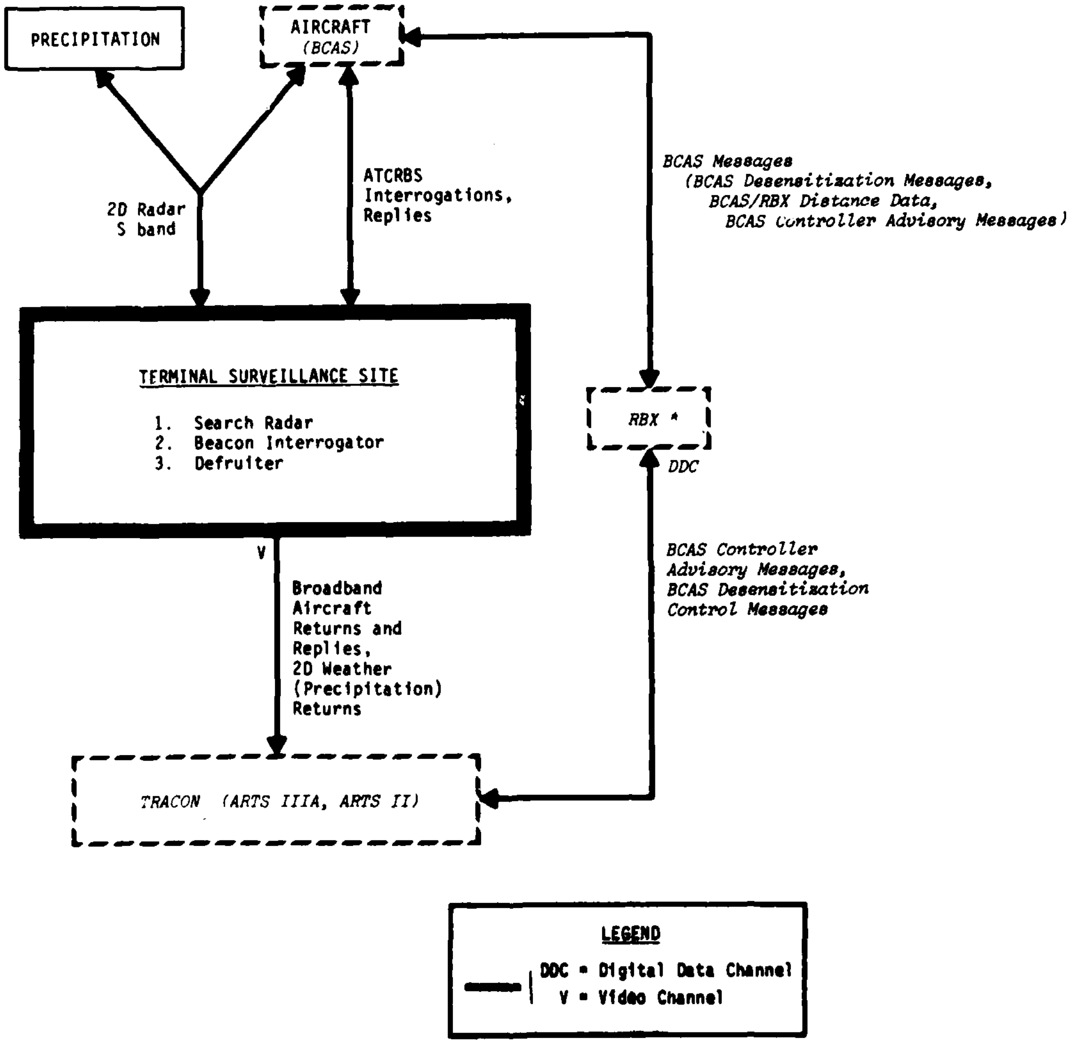


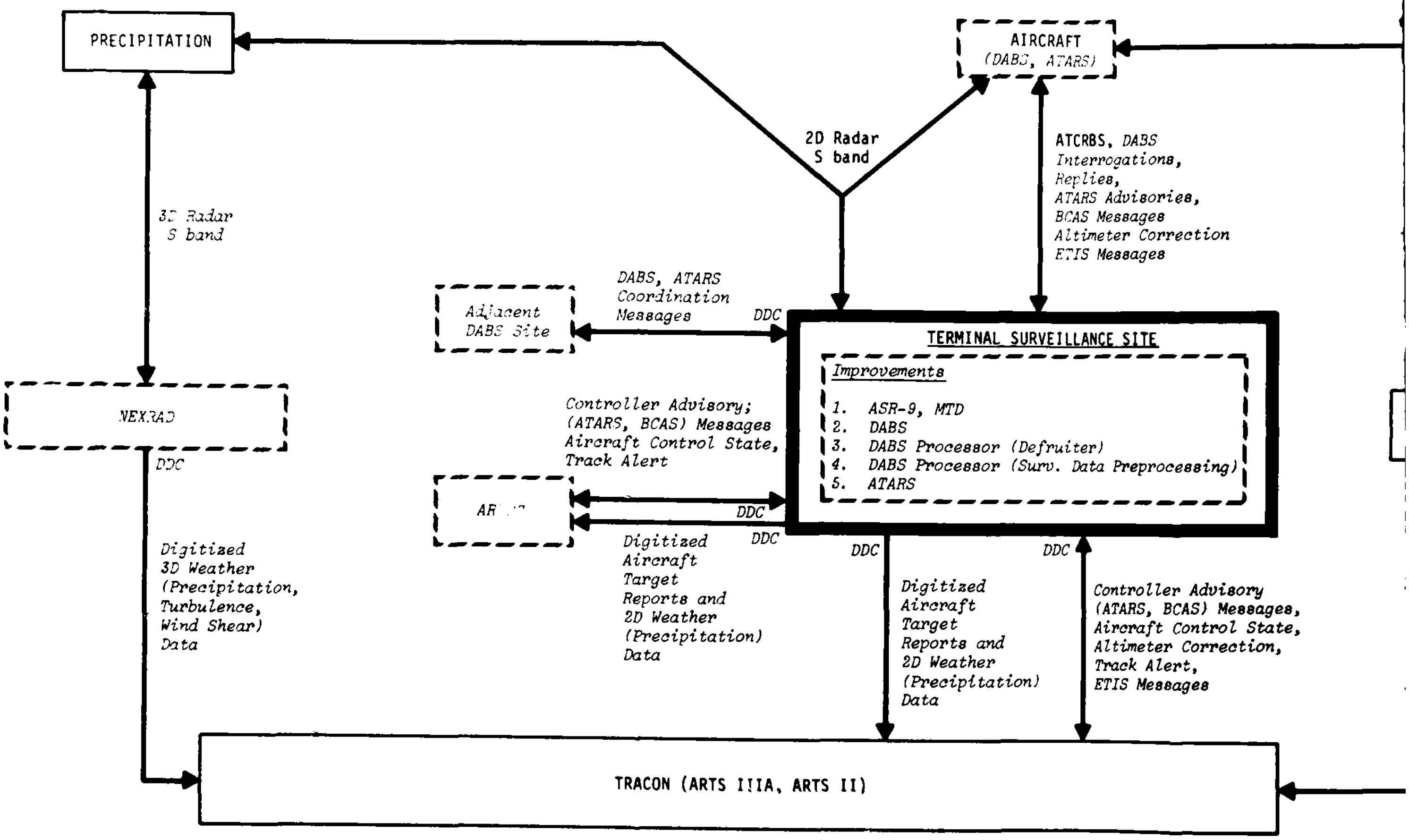
FIGURE 7-11
CURRENT TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM



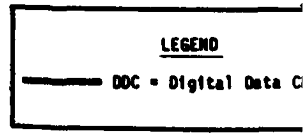
NOTE: Changes from the Current System to the Near Term are indicated in *italics*.

* *RBX probably will not be located at an airport that has a terminal DABS site.*

FIGURE 7-12
NEAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.



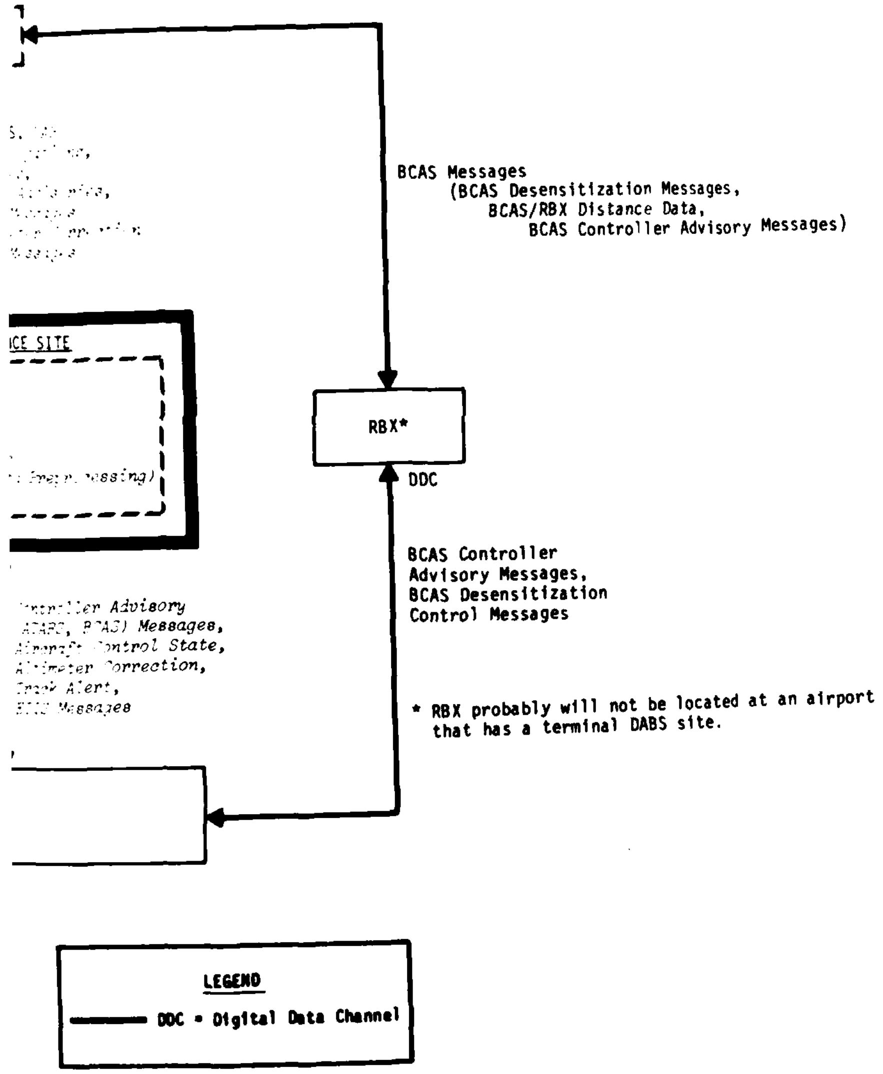


FIGURE 7-13
FAR TERM TERMINAL SURVEILLANCE SITE CONNECTIVITY DIAGRAM

There are three significant changes in connectivity when the Near Term improvements are implemented.

- BCAS messages will be sent via the RBX to the aircraft.

- BCAS desensitization control messages will be sent from the TRACON to the RBX.

- BCAS controller advisory messages may be sent to the TRACON from the aircraft via the RBX.

In the Far Term, six additional changes in connectivity may be made.

- Digitized surveillance data will be sent to the TRACON from the DABS site.

- ATARS advisories, Enhanced Terminal Information Service (ETIS) messages, BCAS messages, and altimeter correction advisories may be sent to the pilot via the DABS data link.

- ATARS and BCAS controller advisory, track alert, and ATARS recording messages may be sent from the DABS site to the TRACON; and aircraft control state, ETIS and altimeter correction messages may be sent from the TRACON to the DABS site.

- Digitized DABS surveillance data, ATARS and BCAS controller advisory and track alert messages may be sent from the DABS site to the associated ARTCC; and the

aircraft control state message may be sent from the ARTCC to the DABS site.

- DABS and ATARS coordination messages may be sent to some adjacent DABS sites.

- Three dimensional weather data, including turbulence and wind shear, may be sent from the NEXRAD to the TRACON and the Tower Cab.

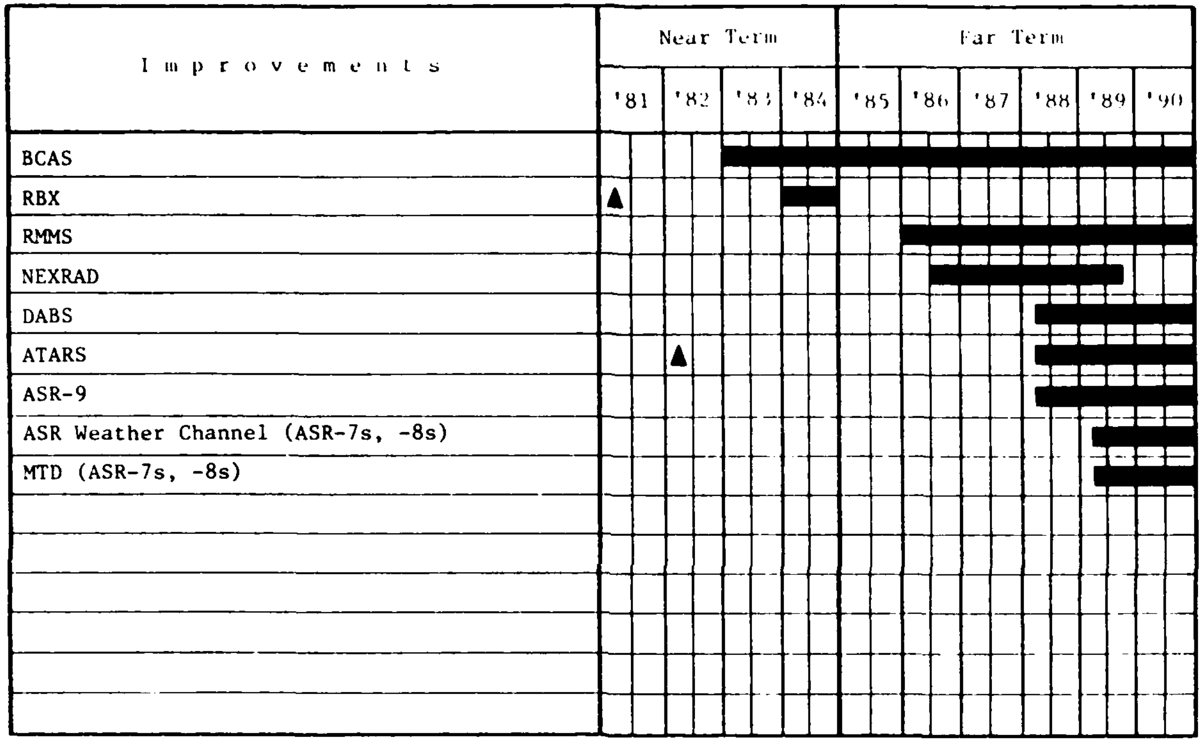
7.2.6 Terminal Surveillance Improvements Tentative Implementation Schedule

A tentative implementation schedule for the terminal surveillance improvements is given in Figure 7-14. Implementation information on these improvements is based upon data supplied by the FAA program managers involved with these projects.

7.3 Surveillance Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a Surveillance Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration issues cited below were identified during the preparation of this document and were reviewed with the



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

▲ = Technical Data Package Handoff

FIGURE 7-14
TERMINAL SURVEILLANCE FACILITIES
TENTATIVE IMPLEMENTATION SCHEDULE

appropriate FAA program managers. Follow-up on these issues was undertaken by a joint Systems Research and Development Service and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in early December 1980. The reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions.

The intergration issue assumptions pertinent to Surveillance Facilities are:

Broad DABS, ATARS Assumptions

Issue 202: Use of DABS/ATARS Data by En Route and Terminal Automation Facilities

It was assumed that in the Far Term, ATARS Advisories and DABS data will be sent from Terminal DABS Sites to Terminal ATC Facilities and to some adjacent En Route ATC Facilities. En Route DABS Sites will be implemented as longer range improvements. ATARS Advisories and DABS data will be sent from the En Route DABS Sites to En Route ATC Facilities. En Route and Terminal Automation Facilities will display received advisories to their controllers.

Issue 212: DABS Maintenance Concept

It was assumed that Terminal DABS sites will have a Remote Maintenance Monitor System (RMMS) in the Far Term.

Issue 706: ATARS Advisories on Non-Mode C Aircraft

It was assumed that proximity advisories will be sent to ATARS-equipped aircraft for target aircraft that are Mode A equipped or are tracked by search radar.

Issue 702: DABS/ATARS Operational Procedures Description

It was assumed that an operational procedures description will be available to specify the needed design and implementation features.

Terminal DABS, ATARS Assumptions

Issue 326: SRAP

It was assumed that when DABS is implemented at a Terminal Surveillance Facility whose search radar does not have the Moving Target Detector capability, a portion of SRAP (Sensor Receiver and Processor) will be installed at the Terminal Surveillance Facility and used as a Radar Data Acquisition System (RDAS) to provide digitized search radar data to DABS. The SRAP at the ARTS site will be removed since ARTS will then receive digitized search data processed by DABS.

Issue 710: ASR-9s at ARTS IIIA Sites

It was assumed that the timing of the installation of any ASR-9s at Terminal Surveillance Facilities will be independent of the timing of DABS implementation at those

facilities.

Issue 711: Reconstituted Video for DABS, Search Radar (ARTS IIIA)

It was assumed that Video Reconstitutors will be used at some ARTS IIIA sites to convert DABS surveillance data for display on existing ARTS IIIA time-shared displays. Digital displays will be available at some ARTS sites that receive DABS during later phases of the DABS implementation.

Issue 302: ARTS II - DABS Interface

It was assumed that video reconstitutors will be used to convert digitized surveillance data for display on existing ARTS II time-shared displays. ARTS II software to utilize DABS surveillance data will be developed based on the ARTS IIIA/DABS interface software.

Issue 317: ARTS IIIA Hardware for Use with DABS

It was assumed that additional processing, storage and communications capabilities will be provided at ARTS IIIA locations to support DABS.

Issue 305: ARTS IIIA Software for the DABS Era

It was assumed that commissionable software to process and display DABS surveillance data and ATARS advisory messages at an ARTS IIIA site will be developed based on the FAATC (FAA Technical Center) TATF (Terminal Automation Test

Facility) software used to test DABS. DABS will treat ARTS IIIA as a non-correlating user of surveillance data.

Issue 310: DABS/ATARS at Multi-Beacon ARTS IIIA Sites

It was assumed that DABS and ATARS data from multiple DABS sites applicable to a particular ARTS IIIA site will be forwarded and directed to the appropriate control position through ARTS IIIA - based software.

Issue 707: ATARS Terrain Avoidance, Terminal MSAW

It was assumed that ATARS will contain an Avoidance Advisory function for Terrain, Obstacles, and Special Airspace. It is further assumed that at some point this function will be merged with terminal MSAW.

En Route DABS, ATARS Assumptions

Issue 208: ARTCC Software for Use With DABS

It was assumed that the initial software will be able to handle DABS terminal surveillance data, ATARS data, and interfacility control and coordination requirements (e.g., Aircraft Control State). Later software will handle en route surveillance site data.

BCAS, DABS Assumptions

Issue 333: Full BCAS - Beacon Radar Site Antenna Rotational Stability

It was assumed that the beacon radar site antenna systems would be modified to improve their rotational stability if required to support full BCAS.

Search Radar, Weather Radar Assumptions

Issue 712: Future Role of Primary Radar

It was assumed that the ARSR-4 as described herein will be deployed.

Issue 713: NEXRAD/Weather Channel Development

It was assumed that the ARSR-4 weather channel and the ASR-9 weather channel will be implemented. Supplemental weather data above that provided by NEXRAD will be provided by the ASRs and ARSRs.

Issue 206: Weather Program Definition

It was assumed that in the Far Term, the CWSU will distribute tabular weather data to TIDS and ETABS for display to controllers. Further assumptions as to the exchange, use, and display of weather data are contained in Issue 207.

Issue 207: En Route Weather Display Concept

It was assumed that controllers will be provided with two-dimensional weather data from WSR-57s on EWEDS 10" (vertical) sector displays in the Near Term. Three-dimensional digitized, Doppler weather data will be available from NEXRAD in the Far Term. Turbulent area information from this data will be displayed as hazardous area contours on PVDs in the Far Term. Extensive use of the three-dimensional characteristics of NEXRAD data will not occur until after the ATC Computer Replacement has been accomplished.

8. NAVIGATION FACILITIES

This chapter describes the system improvements planned for the Navigation Facilities and the interfaces with other ATC facilities for Current, Near Term, and Far Term periods. The ATC facilities and time periods are defined in Chapter 1. The description in this chapter includes the FAA ground facilities that provide navigation information to aircraft in en route and terminal area airspace, and during approach and landing. First, the functions currently performed by various Navigation Facilities and the anticipated improvements are described in Section 8.1. Then, a description of the connectivity changes due to these improvements is given in Section 8.2, and a brief discussion of the tentative time phasing of these improvements is given in Section 8.3. In the final section, Section 8.4, some of the major assumptions that were made with regard either to interfaces with other ATC facilities or to the time phasing of the various navigation improvements are summarized.

8.1 Navigation Facilities Improvements

The anticipated navigation improvements are listed in Table 8-1. There are no Far Term improvements planned at the present time. However, the FAA is currently participating in the Department of Transportation's development of a Federal Radionavigation Plan (see Reference 8-1). The primary goal of the plan is to provide the framework for selecting from a number of existing or planned radionavigation systems, a suitable mix of systems which can meet the diverse user requirements in the post-1995 time frame, while minimizing the duplication of Government-provided services. This could lead to a reduction in

TABLE 8-1
NAVIGATION FACILITIES IMPROVEMENTS

	Near Term Improvements (1981-1984)	Far Term Improvements (Post-1984)	Potential and Longer Range Improvements
En Route and Terminal Area	Solid State VORTAC* VORTAC RMMS*	NC	4D Navigation, CDTI Helicopter IFR Operations NAVSTAR GPS
Approach and Landing	Additional ILSs* Additional VASIs* HUD MLS	NC NC NC NC	

ABBREVIATIONS

*	Approved by the FAA for Implementation
CDTI	Cockpit Display of Traffic Information
GPS	Global Positioning System
HUD	Head Up Display
ILS	Instrument Landing System
MLS	Microwave Landing System
NC	No Change Included in Current Plans
RMMS	Remote Maintenance Monitoring System
TACAN	Tactical Air Navigation
VASI	Visual Approach Slope Indicator
VOR	Very High Frequency Omnirange Station
VORTAC	Colocated VOR and TACAN

the Government's cost for all navigation systems used in the post 1990s, and impact future improvements not yet planned.

8.1.1 En Route and Terminal Area Navigation Facilities

Since non-FAA navigation facilities are used by some aircraft as a supplement to the FAA facilities, both types of Navigation Facilities are described below.

8.1.1.1 FAA Navigation Facilities

En route and terminal area navigation information is currently provided by three types of FAA ground facilities: VOR, VOR-DME, and VORTAC.

A VHF Omnidirectional Range (VOR) ground site transmits azimuth information relative to the ground site via AM and FM signals modulating a VHF carrier. The phase difference between the AM and FM signals is used by all civil and some military aircraft to determine their bearing with respect to the VOR. The VOR may also be used to periodically transmit Automatic Terminal Information Service (ATIS) messages which are pre-recorded in the Tower Cab or Transcribed Weather Broadcast (TWEB) messages which are pre-recorded at FSSs.

A VOR-DME ground site co-locates a VOR with Distance Measuring Equipment (DME). A DME receives L band pulse interrogations from suitably equipped aircraft in the vicinity and responds with similar pulses. The distance between the aircraft and the DME ground site can then be calculated by the aircraft by measuring the difference in time between the aircraft's

interrogation and the reception of the DME ground site's reply. DME equipment is used by both civil and military aircraft.

A VORTAC ground site, as shown in Table 8-2, consists of colocated VOR and Tactical Air Navigation (TACAN) equipment. TACAN is a military navigation system that provides DME distance information, and provides its own azimuth information via amplitude modulation of the DME pulse transmissions. The DME portion of TACAN is used by both civil and military aircraft and the azimuth portion is used by military aircraft. Thus, VORTAC is a compatible civil/military navigaton system. Table 8-3 provides a count of the commissioned en route and terminal area navigation ground sites as of September 1980.

These ground facilities are distributed across the Conterminous United States to define three route systems: VOR Airways, Jet Routes, and RNAV.

The VOR Airway System consists of airways designated from 1200 feet AGL to 18,000 feet MSL and are referred to as "Victor" Airways. The Jet Route System has routes from 18,000 feet MSL to 45,000 feet MSL. Both the Victor Airways and the Jet Routes utilize VOR radials to define route segments.

The Area Navigation (RNAV) Route System has routes in the same altitude band as the Jet Routes. RNAV Routes utilize both VORs and DMEs for navigation information, but unlike the Victor Airways and Jet Routes, RNAV Routes do not restrict the aircraft to fly along routes defined by VOR radials. Thus, RNAV Routes give equipped aircraft greater flexibility in route selection.

TABLE 8-2
VORTAC FUNCTIONS AND EQUIPMENT

Functions	Equipment
1. VOR	
• Transmits Azimuth Information	VOR Transmitter (VHF)
• Transmit ATIS or TWEB Information	
2. DME	
• Detect Aircraft DME Interrogations	DME Receiver (L Band)
• Transmit DME Replies	DME Transmitter (L Band)
3. TACAN	
• Detect Aircraft TACAN (DME) Interrogations	TACAN (DME) Receiver (L Band)
• Transmit TACAN (DME) Replies and Azimuth Information	TACAN Transmitter (L Band)

TABLE 8-3
CURRENT FAA EN ROUTE AND TERMINAL AREA
NAVIGATION GROUND SITES

VOR	189
VOR-DME	21
VORTAC	705
	915 (As of 9/80)

Special RNAV routes have recently been created for helicopter operations in the Northeast corridor from Boston to Washington, D. C., and consideration is being given to random RNAV routing based on a helicopter operators immediate needs.

Near Term Improvements

In the Near Term, as shown in Table 8-1, the FAA is planning to replace all vacuum tube VORs and VORTACs, and all DMEs colocated with a VOR with solid state equipment in order to increase the reliability and maintainability of the VOR/DME/TACAN navigation system. This improvement is referred to as either the Solid State VORTAC or the Second Generation VORTAC, and it is functionally equivalent to the existing ground facilities. Included in the improvement is the installation of the Remote Maintenance Monitor System (RMMS) which will monitor the performance of each VOR/DME/TACAN site, and forward VOR/DME/TACAN status information to an associated FSS. The FSS, in turn, will forward the status data to an associated ARTCC. (See Chapter 2 for a discussion of RMMS). Both the introduction of the solid state technology and RMM are expected to substantially reduce the operational and maintenance costs.

Potential and Longer Range Improvements

Beyond this anticipated improvement, the FAA is also tentatively exploring 4D navigation as another possibile improvement. 4D Navigation is a type of RNAV in which arrival time is one of the parameters of the system. It might be used in high density terminal airspace in conjunction with terminal sequencing and spacing, and as a backup to a highly automated ATC system.

8.1.1.2 Non-FAA Navigation Facilities

Besides the FAA, various other governmental agencies maintain ground stations which transmit navigation information for their own use. For example, the Coast Guard maintains LORAN-C and OMEGA ground sites to provide maritime navigation information, and the Navy maintains VLF-NAVCOM ground sites for communications with its fleet. (Since the VLF-NAVCOM sites transmit time stable signals, they can also be used to provide navigation information.) This information can also be used by some aircraft as a supplement to the VORTAC system.

Some air carriers are currently using OMEGA to provide navigation information during oceanic flights, and the FAA recently permitted helicopters to use LORAN-C to fly to and from offshore oil rigs. Helicopters can also use an airborne radar approach (ARA) to locate the rigs in IFR weather. ARA utilizes an X band airborne radar to provide guidance to the rig either with "skin" returns, or on a beacon transponder located at the oil rig. In the future, these transponders may have assigned codes so that an individual rig can be identified in a field of rigs.

LORAN-C is being tested for both en route and non-precision approach use. The state of Vermont wants to have LORAN-C certified for instrument flight use in its area. In the Gulf of Mexico, the FAA and industry will demonstrate flight following in 1981 using LORAN-C helicopter position information automatically data-linked back to ATC on shore.

The FAA is also studying the possible utilization of the NAVSTAR

Global Positioning System (GPS) in the 1990s as a replacement for the present VORTAC System. NAVSTAR GPS may be deployed by the Department of Defense in the late-1980s. It would consist of 18 to 24 satellites and would provide accurate navigation information on a worldwide basis for a number of military users. This system might eventually also replace or supplement other civilian navigation systems, such as VORTAC, OMEGA, and LORAN-C, sometime after 1995. However, before the FAA can make a decision to replace the VORTAC System, further analysis will have to be performed to prove: the operational feasibility of this type of navigation system; its cost-effectiveness for both the FAA and the various potential civil aviation users; and its international acceptabiltiy.

8.1.2 Approach and Landing Navigation Facilities

As shown in Table 8-4, the FAA currently maintains several types of ground facilities for three types of approaches: Precision and Non-precision Instrument Approaches, and VFR Approaches. Instrument approach procedures are established by the FAA for individual runways at specific airports, and they may have as many as four separate segments depending on how the approach procedure is structured. The four segments are: initial approach, intermediate approach, final approach, and missed approach. The final approach segment, i.e., the segment between the final approach fix and the runway, may either be a Precision or Non-precision Instrument Approach.

8.1.2.1 Precision Instrument Approaches

Precision Instrument Approaches are performed utilizing

TABLE 8-4
CURRENT APPROACH AND LANDING NAVIGATION FACILITIES
FUNCTIONS AND EQUIPMENT

			Functions	Equipment
Instrument Approaches	Precision	ILS	• Transmit Horizontal Guidance • Transmit Vertical Guidance • Transmit Marker Locations • Detect Aircraft DME Interrogations • Transmit DME Replies • Visual Horizontal Guidance	Localizer Transmitter (VHF) Glide Slope Transmitter (UHF) Marker Beacons (VHF) DME Receiver (L Band) DME Transmitter (L Band) Approach Lights
	Non-Precision	Partial ILS	• Transmit Horizontal Guidance • Transmit Marker Locations • Visual Horizontal Guidance	Localizer Transmitter (VHF) Marker Beacons (VHF) Approach Lights
		VOR	• Transmit Horizontal Guidance	VOR Transmitter (VHF)
		NDB	• Transmit Homing Signal	NDB Transmitter (LF or MF)
VFR Approaches		VASI	• Visual Vertical Guidance	VASI Light Bars

horizontal and vertical guidance information that is currently provided by an Instrument Landing System (ILS). As of January 1981, there are approximately 957 full or partial ILSs commissioned or planned for 658 U.S. airports (see Table 8-5). A full ILS generates several electronic signals (Localizer, Glide Slope, Marker Beacons, and in a few cases, DME). It also has an associated approach lighting system to provide visual guidance.

The Localizer signal provides horizontal guidance information from a minimum distance of 18 nautical miles to the runway to align the aircraft with the runway centerline. This navigation information is provided by amplitude modulating a VHF carrier frequency with continuous 90 Hz and 150 Hz tones. When the difference in depth of modulation of both tones received by the aircraft is zero, the aircraft is on course.

The Glide Slope signal provides vertical guidance by defining a glide path to the runway which is approximately at a 3^{o} elevation angle with respect to the runway at the touchdown point. This navigation information is provided by amplitude modulating a UHF carrier frequency in the same manner as the Localizer signal.

As shown in Table 8-6, there are three categories of Precision Instrument Approaches. A Category I ILS system, the system most widely used today, permits approaches to be performed only under higher visibility and decision height criteria than Category II or IIIA systems. The decision height is the altitude at which the pilot must be able to visually acquire either the runway or the approach lights during the precision approach, or execute a

TABLE 8-5
CURRENT AND PLANNED ILS DEPLOYMENT

	Number of ILSs	Number of Airports
Non-Precision Approach (Partial ILS No Glide Slope)	134	125
Category I Precision Approach	737	451
Category II Precision Approach (Operational)	47	43
Category II Precision Approach (Additional Designated Sites)	27	27
Category IIIA Precision Approach	12	12
Total	957	658

TABLE 8-6
PRECISION INSTRUMENT APPROACH CATEGORIES

	Landing Minima	
Category	Runway Visual Range (RVR)	Decision Height
I	2400 Feet	200 Feet
II	1200	100
IIIA	700	0

missed approach.

The Outer Marker Beacon is normally located at the point at which an aircraft will intercept the ILS glide path if it is at the appropriate altitude on the localizer course as defined by the instrument approach procedure. The Middle Marker is located at the point at which the pilot has to visually acquire either the runway or approach lights during a Category I landing, typically when the aircraft is approximately 1/2 nmi from the runway threshold and at an altitude of 200 feet above the runway. The Inner Marker Beacon is located at the point at which the pilot has to visually acquire either the runway or approach lights during a Category II landing, when the aircraft is at an altitude of 100 feet or more above the runway. Marker Beacons transmit a unique tone that is amplitude modulated on a 75 MHZ carrier and uniquely coded with a repetitive series of dots and dashes. Both the tone frequency and code vary with each Marker Beacon so that they can be individually identified.

In addition to, or in place of Marker Beacons, some ILSs utilize a DME to inform the pilot of his distance from the runway.

The approach lights aid the pilot in transitioning from instrument flight to visual flight either at the middle or inner marker by providing visual cues to keep the aircraft aligned with the runway centerline. The approach lights consist of rows of lights along the approach path from a point 1000 to 3000 feet from the runway threshold to the threshold. The lighting systems associated with a Category II system are more elaborate than those associated with a Category I system.

A few category III ILSs have been commissioned in the U.S. These systems permit landings by appropriately equiped aircraft in visibility conditions down to 700 ft visibility range and zero decision height.

8.1.2.2 Non-Precision Instrument Approaches

Non-precision Instrument Approaches are performed utilizing horizontal navigation information that is provided by a localizer-only ILS, VOR, Non-directional Beacon (NDB), or Compass Locator.

All of these ground facilities provide navigation information to locate either a runway centerline for a straight-in approach, or the airport for a circling approach. Each approach has a minimum descent altitude associated with it, below which the pilot cannot descend to complete the landing unless he can visually acquire either the runway or the approach lights.

VORs, NDBs and Compass Locators may provide navigation information for either straight-in or circling approaches based upon their location in relation to the particular runway centerline. 2D RNAV may be used to provide a straight-in approach at an airport with only a VOR circling approach (due to the VOR's location), since the RNAV system on board the aircraft could utilize the VOR-DME navigation information to generate information for a straight-in approach.

NDBs transmit a continuous LF or MF omnidirectional signal that is amplitude modulated with a three-letter identification code, except during voice transmission of pre-recorded messages

(TWEBs) sent from Flight Service Stations. Compass Locators are similar to an NDB, except that they are low powered providing limited coverage, transmit a two-letter identification code, and are used in conjunction with ILS marker beacons. A pilot can utilize the omni-directional signal from either an NDB or a Compass Locator with the aircraft's automatic direction finder and heading indicator to perform a Non-precision Instrument Approach.

8.1.2.3 Approaches By VFR Aircraft

Approaches by VFR aircraft utilize a VFR traffic pattern and can only occur when the weather is at or above the basic VFR weather minimums, as follows. (If there are obstacles in the vicinity of the airport, the minimums will be higher.)

- In controlled airspace - visibility 3 miles, ceiling 1000 feet AGL.

- In uncontrolled airspace - visibility 1 mile, aircraft clear of clouds.

The FAA has installed Visual Approach Slope Indicators (VASIs) at a number of airports to provide vertical guidance information during a Visual Approach or an approach by a VFR aircraft to a runway. The standard VASI consists of light bars that provide the pilot with a visual cue that he is on, above, or below a 3^{o} glide path during the approach to the runway. VASIs are also used at ILS runways to provide additional guidance to the pilot.

The FAA is also planning to test a laser system to provide

visual guidance for helicopters to heliports.

8.1.2.4 Approach and Landing Navigation Facilities Improvements

In the Near Term, three improvements are anticipated:

- The replacement of vacuum tube ILSs with solid state ILSs to improve equipment reliability and maintainability, and the installation of ILSs at additional airports.

- The installation of 100 or more VASIs per year at airports through the mid-1990s.

- The installation of Microwave Landing Systems (MLSs) at several airports as the FAA begins the transition from ILS to MLS.

In comparison with ILS, MLS has several major advantages:

- Due to its higher transmission frequency (C-band) MLS allows antennas to be built with narrow beamwidths that minimize dependence on the surrounding ground plane. Therefore, MLS will be less susceptible to signal transmission problems caused by the terrain and nearby structures, tidal variations and snow. Thus, its installation at some airports with difficult siting problems should become economically feasible.

- Due to the increased integrity of its guidance signals, MLS should encourage the use of automatic landings. The

MLS should provide the pilot with the confidence to utilize automatic, coupled approaches all the way to touchdown.

- Due to its scanning technique in both the horizontal and vertical planes, MLS will provide a wider coverage area. This, in turn, will permit the utilization of curved approaches and various glide paths at the more sophisticated sites by suitably equipped aircraft.

8.1.2.5 Associated Improvements

Two other system improvements, indirectly related to navigation, are also being considered by the FAA: the use of Head Up Displays (HUD) in the Near Term and the Cockpit Display of Traffic Information (CDTI) as a Potential and Longer Range improvement.

CDTI is a cockpit display which might provide the pilot with information on other air traffic in his vicinity. The data for the display would be sent from the ATC System via the Discrete Address Beacon System (DABS) data link. Some of the possible uses of CDTI are:

- Controller assistance to the pilot in merging and spacing,

- Improvement of the pilot's awareness of other air traffic,

- ATC back-up assistance in case of equipment failures,

- Blunder detection,

- En Route Operations (such as weather avoidance or 4D RNAV)

The utilization of Head Up Displays (HUDs) is expected on board some air carrier aircraft to aid pilots in the transition from instrument to visual flight during an instrument approach. A HUD is expected to enhance the pilot's ability to execute a manual landing with less likelihood that the aircraft will descend below the glide path after the decision height has been reached.

8.2 Navigation Facilities System Connectivity

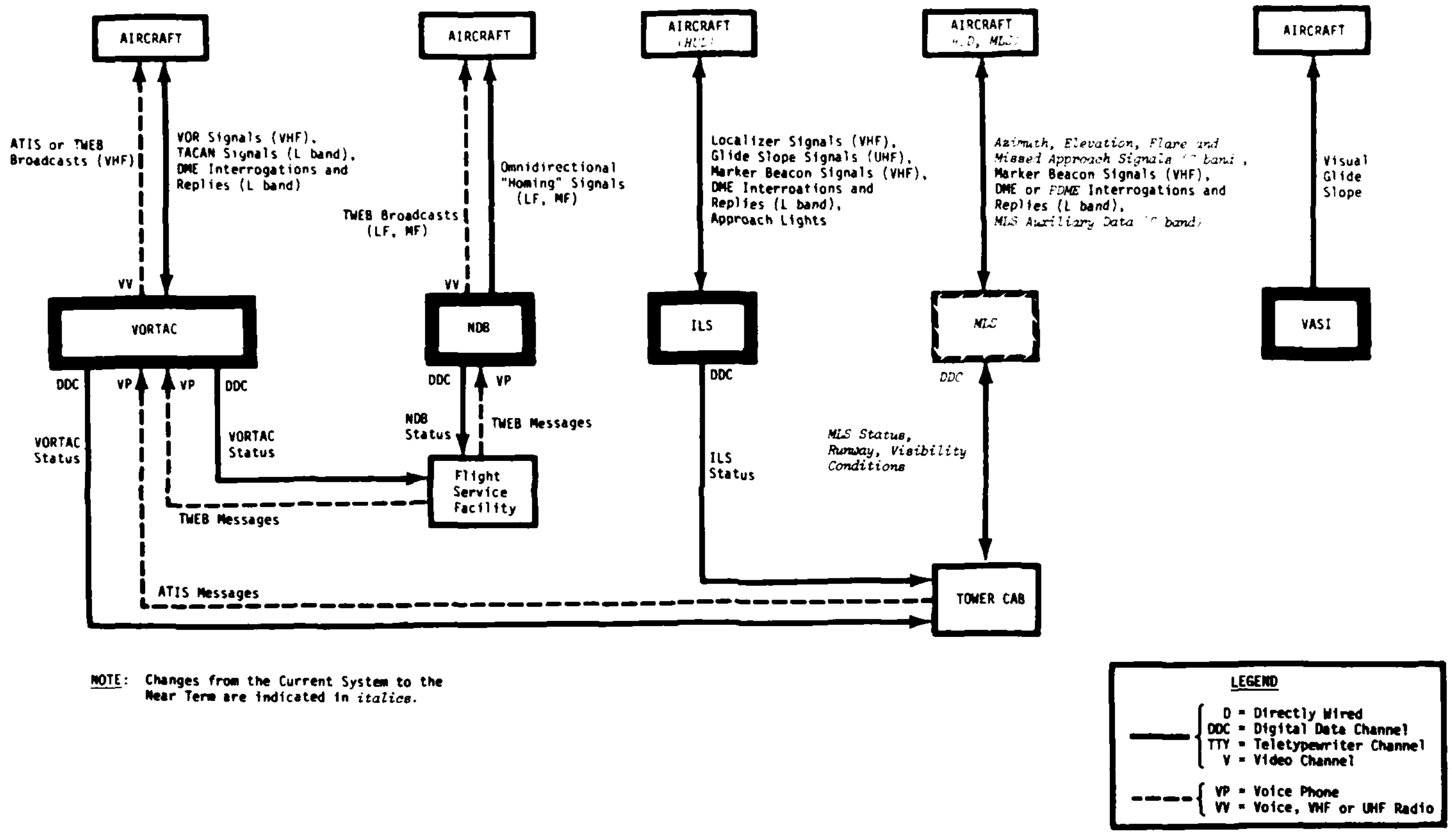
As shown in Figure 8-1, MLS (Reference 8-2) would be the only anticipated improvement in FAA navigation ground facilities that affects either ATC system connectivity, external information flow, or the internal functions performed at a ground facility.

From a system connectivity viewpoint, MLS navigation signals transmitted to the aircraft will change in comparison with ILS in six ways.

- The transmission frequency of the MLS will be C band instead of VHF or UHF.

- Azimuth and Elevation signals will be provided instead of Localizer and Glide Slope signals.

- Back azimuth signals will be transmitted at some



NOTE: Changes from the Current System to the Near Term are indicated in *italics*.

FIGURE 8-1
NAVIGATION FACILITIES CONNECTIVITY DIAGRAM

airports to provide horizontal guidance during a missed approach or departure.

- Precision DME (PDME) signals will be transmitted at some MLS sites to support complex approaches and automatic landings. The aircraft's radar altimeter or an optional MLS flare element may be used to execute the flare maneuver with the aid of the PDME. The PDME will provide highly accurate distance information along the final approach path and will be compatible with the existing international airborne and ground DME standards.

- All MLS sites will transmit basic digital data inherent to the operation of the system. In addition, the MLS auxiliary digital data channel can be used to transmit such items as meteorological and runway conditions, siting parameters, way points that define an unconventional approach, e.g., a horizontally or vertically segmented approach. At the present time, there is no ICAO standardization for the auxiliary data.

- DME signals will eventually be used instead of marker beacon signals to locate key points during the approach.

From a functional viewpoint, the navigation information provided by an MLS would be different from an ILS. Multiple glide paths and azimuth positions will be provided by an MLS instead of a single approach path, thereby permitting curved approaches within 40° of the runway centerline and descents along glide paths from 0.9° to 7.5° depending on the type of aircraft.

The FAA is considering three configurations of MLS systems (see Table 8-7). The simplest type of MLS is the Small Community MLS (SCMLS). This system will provide proportional azimuth coverage when the aircraft is within $\pm 10^{\circ}$ of the centerline, and will provide fly right or fly left guidance to the pilot between $\pm 10^{\circ}$ and $\pm 40^{\circ}$ of the centerline. Proportional elevation coverage is provided to at least 7.5°. The SCMLS will be used primarily on runway lengths of up to 5000 feet.

The Basic MLS system has a broader range of coverage for proportional azimuth and elevation angles than the SCMLS. An azimuth antenna beamwidth will be used for runway lengths of less than 8,000 feet providing proportional guidance $\pm 40^{\circ}$ of centerline.

The Expanded MLS system is the most sophisticated MLS system planned by the FAA to support all weather operations. This system can provide increased proportional coverage or added services. Besides including a backcourse azimuth signal for missed approaches or departures, it may also provide optional flare guidance.

MLS Azimuth, Elevation, Flare and Missed Approach signals will be provided by the time reference scanning beam (TRSB) method in which a narrow unmodulated fan beam scans at high speed in alternate directions through the coverage sector. The scanning speed will be uniform, starting from one extremity of the coverage sector and moving to the other and then back to the starting point. The Azimuth beams will scan from left to right of the runway centerline and then right to left, while the Elevation and Flare beams will scan up then down towards the

TABLE 8-7
TYPES OF MLS SYSTEMS

	Small Community MLS (SCMLS)	Basic MLS	Expanded MLS
Azimuth	$\pm 10^\circ$*, 2° or 3°BW**	$\pm 40^\circ$, 1° or 2° BW	$\pm 60^\circ$, 1°BW
Elevation	0.9°-7.5°, 2°BW	0.9°-7.5°, 1.5°BW	0.9°-15°, 1°BW
DME	Conventional	PDME	PDME
Flare	-	-	0°-10° (Optional)
Backcourse Azimuth	-	$\pm 20^\circ$ (Optional)	$\pm 20^\circ$
Basic Data	All	All	All
Auxiliary Data	-	Optional	Required
Redundancy	No	Optional	Yes
360° Azimuth	-	Optional	Optional

* $\pm 40^\circ$ Non-Proportional Signal

** BW = Beam Width

ground.

In every scanning cycle, two pulses (To, Fro) will be received by the aircraft from each scanning beam. The time interval between the To and Fro pulses will be proportional to the angular position of the aircraft with respect to the runway centerline (Azimuth) or the ground (Elevation, Flare), and the high update rates for these signals, 13 or 39 Hz for Azimuth and 39 Hz for Elevation, will make it possible to design simple airborne processors that can minimize multipath effects.

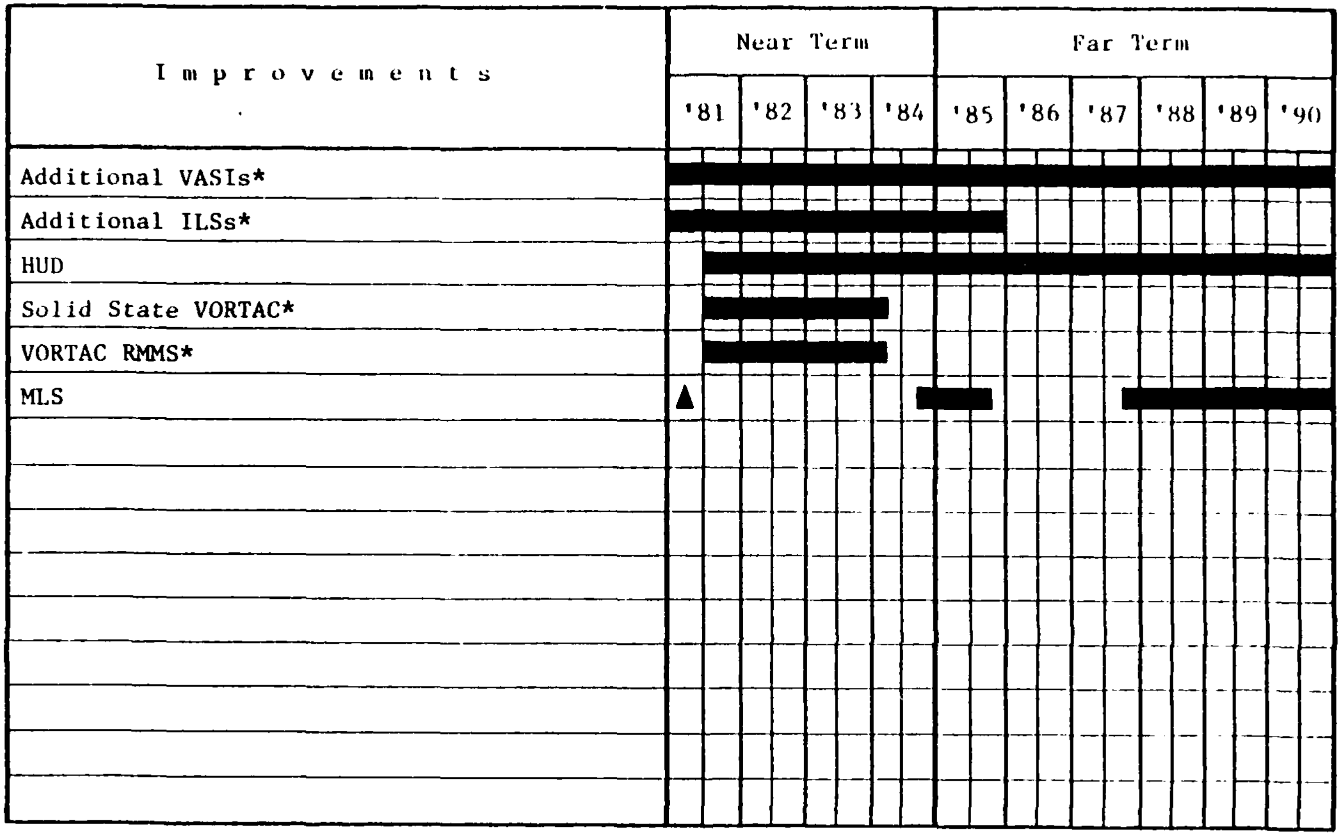
The Azimuth, Elevation, Flare and Missed Approach signals, and data messages will be time-multiplexed so that a single aircraft receiver can process all of the information. Each guidance signal will be preceded by a preamble which will set the aircraft's MLS receiver for the function which follows.

Only the most sophisticated MLS sites would transmit all of the possible guidance signals. At the most elementary MLS sites, only Azimuth, Elevation and basic data from the MLS, and DME or Marker Beacon signals will be transmitted.

8.3 Navigation Improvements Tentative Implementation Schedule

Figure 8-2 provides a tentative implementation schedule for the Navigation Facilities improvements. It should be emphasized that this schedule may change in the future as a result of additional information concerning the need and the progress of the individual projects.

Information on the Near Term improvements was obtained from



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 8-2
NAVIGATION FACILITIES
TENTATIVE IMPLEMENTATION SCHEDULE

preliminary budgetary information for Fiscal Years 1981 to 1984, and information on the Far Term improvements was obtained from the FAA program managers involved with these projects.

In the Near Term, the FAA is planning to install MLSs at a limited number of airports. After these systems have been evaluated in an operational environment, then additional MLSs will be installed in the Far Term.

Due to the age of some of the ILS equipment, the FAA may have to continue to purchase new equipment to replace existing equipment while MLS is being introduced. In addition, the FAA will maintain ILSs after the MLSs have been installed to accommodate different user needs during a transition period. Both types of landing systems may be maintained at the same site for a relatively long time interval, perhaps as long as 15 years.

8.4 Navigation Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function at a Navigation Facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issues cited below were identified during the preparation of this document and were reviewed with the appropriate FAA program managers. Follow-up on these issues was undertaken by a joint Systems Research and Development Service

and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in early December 1980. The reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions.

The integration issue assumptions pertinent to navigation Facilities are:

Issue 801: Use of the MLS Data Link

It was assumed that ICAO will standardize the MLS Auxiliary Data format, and the messages will include the following information:

- Runway condition,
- Runway visibility,
- MLS siting data, and
- MLS status.

Issue 803: MLS Display Requirements

It was assumed that the Microwave Landing System (MLS) data for the pilot may be displayed on an integrated display which may also include some of the following displays: the Head Up Display (HUD), the weather radar display, and existing MLS and navigation displays.

Issue 804: Candidates for Civil Aviation Navigation

It was assumed that the mix of navigation systems selected

to meet aviation user requirements in the 1990s will be determined from those candidates currently under study in the Federal Radionavigation Plan.

Issue 805: Compatibility of Existing Planned Navigation Systems with the ATC System

It was assumed that future ATC airspace and routing procedures will either be modified to accomodate use of all approved navigation systems, or will be restricted to specific navigation systems. The objective is to avoid aircraft using different navigation references from entering into conflicts with other aircraft or obstacles while cleared into common airspace.

9. COMMUNICATIONS FACILITIES

This chapter describes the system improvements planned for the Data and Voice Communications Facilities and the interfaces with other ATC facilities for Current, Near Term, and Far Term time periods. The ATC facilities and time periods are defined in Chapter 1. Data communications are described in Section 9.1 and voice communications in Section 9.2. Connectivity and implementation schedules for both current and proposed communication improvements are also discussed.

The data communications section describes the facilities which provide for switching and transmission of data for FAA ATC operations. All types of ground/ground ATC data communications are described, including low speed point-to-point teletype, multipoint teletype, medium speed (300 through 9600 bps), data concentration and data switching. Dial-up data transmission channels which are accessed through telephone company switching equipment are omitted. Facsimile transmission and broadband radar transmission are included as data communications. Future plans call for meeting these requirements with digital techniques.

The voice communications section considers the facilities that provide air/ground voice communications between FAA ATC facilities and aircraft operating in CONUS, as well as ground/ground voice communications between FAA operated ATC facilities, and between ATC and FSS facilities.

Communications directly impacting the provision of ATC services are included. Communications between the IFR aircraft and terminal and en route controllers, and between VFR aircraft and

Flight Service Stations are also included.

9.1 Data Communications

This section provides a brief discussion of the requirements for data communications among FAA facilities. The improvements and connectivity in each of four areas of automation (En Route, TRACON/Tower, ATCCC and FSS facilities) are discussed. The planned NADIN configuration is described and compared to current FAA data communications facilities. Schedules for implementation are indicated, and some assumptions pertaining to current system configuration issues are identified.

For purposes of this discussion, data communications include: (1) communications between people, where the message is initiated on a keyboard device and is delivered on a page printer, cathode ray tube or printout device; (2) communication from a person to a machine, where the origination is at a keyboard and the delivery is in the form of data or commands for entry into a machine; (3) communication from a machine to a person where the origination is a stream of digital information and delivery is in the form of a printout; or (4) communication from one machine to another. In general, all data communications take the form of binary coded digital information transmitted electrically through wire or other transmission media; however, some analog transmissions are mentioned in this section (i.e., radar transmissions in video form) where there are plans in the Near Term and Far Term to replace this mode with a digital capability.

Specifically excluded from this discussion are connections

between local machines or between a machine and its control console or closely associated user terminals where these equipments are physically located within the same facility and are considered an integral part of a data processing configuration.

9.1.1 Improvements and Connectivity

Various improvements in the FAA data communications service are in the planning or implementation stage. These improvements are described as they apply to each of the time periods (Current, Near Term, and Far Term) for each of the major facility categories (En Route, Terminal, ATCCC and FSS). Overall connectivity diagrams are also included for each category.

9.1.1.1 En Route Facilities Improvements

The en route data communications are comprised primarily of the following services; ARTCC to ARTCC, ARTCC to terminal, radar sites to ARTCC, and various teletype circuits to ARTCC. Some basic assumptions which were used in describing the en route data communications are listed in Table 9-1. The descriptions of en route data communications for the three periods of interest, Current, Near Term and Far Term, as well as Potential and Longer Range improvements, are contained in Table 9-2. An illustration of the configuration for each of the three time periods is shown in Figures 9-1, 9-2, and 9-3. Clarifying information is included in the next subsections.

TABLE 9-1
ASSUMPTIONS FOR EN ROUTE FACILITIES DATA COMMUNICATIONS

1. The NADIN information is per FAA-E-2661, specification for NADIN, January 4, 1977 (Reference 9-7) and the NADIN contract (DTFA01-81-C20006), October 31, 1980.

2. A NADIN concentrator (NADIN 1A) can switch data between computers which are connected to the concentrator, such as ARTCC to ARTS. However, accountable TTY data (i.e. data which must be journaled) must be sent through the switch.

3. The data transfer between ARTCCs in the Far Term will be via NADIN.

4. The ARTS interface with NADIN includes ARTS IIIA, ARTS II, and an ARTS II-like replacement for the TPX-42.

5. TIDS will be installed in ARTS IIIA sites in the Far Term. Installacion in ARTS II sites is a potential and longer range improvement.

6. The NADIN Enhancement interface with ARTS IIIA will be through the TIDS (References 9-2, 9-3, and 9-5) equipment when TIDS is installed in the Far Term.

7. Present FDEP equipment will be used for strip printing in terminals in the Near Term until the FDIO System is implemented.

8. With the implementation of the FDIO system in the Near Term, these FDEP transmission channels will be capable of operating at 2400 bps for the new FDIO printers and CRT/Keyboards.

9. The CD-2 equipment will be implemented in the Near Term. Broadband radar and beacon data will not be retained for backup in the Far Term.

10. DABS surveillance and ATARS services will be provided to some ARTCCs from selected terminal DABS sites when it is implemented in the Far Term. Implementation of en route DABS sites is assumed to take place after the en route ATC computer is replaced.

11. Currently three 2400 bps channels, with three redundant backup channels, are provided for transmitting digitized radar data from the surveillance site to the ARTCC. With the introduction of DABS, up to four (4) 4800 bps per channels will be provided.

TABLE 9-1
(CONCLUDED)

12. With the introduction of DABS, up to three (3) 4800 bps channels shall be provided from the en route surveillance site to the ARTCC for data link and ATARS communications.

13. Digitized weather surveillance data will be available to the ARTCC from NEXRAD weather radar sites in the Far Term.

14. Alphanumeric weather data from the WMSC will be available to the ARTCC via NADIN in the Near Term.

TABLE 9-2
EN ROUTE FACILITIES-DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
1. ARTCC-ARTCC Flight Plan and Handoff Data	Dedicated circuit from en route computer to the en route computer in each adjacent ARTCC (2400 bps) as primary channel. A redundant line is provided (full duplex).	NC	NADIN Enhancements-Data Transfer from en route computer to NADIN concentrator (up to 40 kbps) to NADIN switch (9600 bps), to another NADIN concentrator (9600 bps), then to other en route computer (up to 40 kbps), vice versa (full duplex).	NC
2. ARTCC-ARTS III TRACONS a. Flight Plan and Handoff Data	Dedica‑‑d circuit from each ARTS III computer to the en route computer in the local ARTCC (2400 bps) as primary channel - no redundant lines (full duplex).	NC	NADIN Enhancement-Data transfer from en route computer to NADIN concentrator (up to 40 kbps then to ARTS IIIA computer (2400 bps) via TIDS and vice versa (full duplex).	NC
b. Flight Plan/ Flight Strip Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in ARTS III TRACON (half duplex).	NADIN 1A - Dedicated FDIO channel (2400 bps) from en route computer to NADIN concentrator (up to 40 kbps), then to FDIO equipment in TRACON.	Data transfer same as for Near Term, except interface with ARTS IIIA is via TIDS.	NC

NOTES
NC = No Change in Current Plans
NA = Not Applicable

TABLE 9-2
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
3. ARTCC-ARTS II TRACONS a. Flight Plan and Handoff Data	Dedicated circuit from each ARTS II computer to the en route computer in the local ARTCC (2400 bps) as primary channel - no redundant lines (full duplex).	NC	NADIN Enhancement- Data transfer from en route computer to NADIN concentrator (up to 40 kbps), then to ARTS II computer (2400 bps), and vice versa (full duplex).	Data transfer same as for Far Term except interface with ARTS II via TIDS.
b. Flight Plan/ Flight Strip Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in TRACON (half duplex).	NADIN 1A - Dedicated FDIO channel (2400 bps) from en route computer to NADIN concentrator (up to 40 kbps), then to FDIO equipment in TRACON.	NC	Data transfer same as for Near Term except interface with ARTS II is via TIDS.

TABLE 9-2
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
4. ARTCC-TPX-42 TRACONS a. Flight Plan and Handoff Data	NA	TPX-42 will be replaced with ARTS II. Dedicated circuit from each ARTS II computer to the en route computer in the local ARTCC (full duplex).	See Item 3(a) Far Term	See Item 3(a) Potential and Longer Range Improvements
b. Flight Plan/ Flight Strip Data	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in TPX-42 terminal (half duplex).	NADIN 1A - Dedicated FDIO channel (2400 bps) from en route computer to NADIN concentrator (up to 40 kbps), then to FDIO equipment in TRACON.	See Item 3(b) Far Term	See Item 3(b) Potential and Longer Range Improvements
5. ARTCC-VFR TOWER	Dedicated FDEP channel (75 bps) from en route computer to FDEP equipment in a VFR tower cab to print flight strips (half duplex).	NADIN 1A - Dedicated FDIO channel (2400 bps) from en route computer to NADIN concentrator (up to 40 kbps), to FDIO equipment in VFR tower and vice versa (half duplex).	NC	Data transfer same as for Near Term except interface to VFR tower is via TIDS of associated ARTS III A TRACON.

TABLE 9-2
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
6. Surveillance Sites- ARTCC a. Digitized Search and Beacon Data	Three dedicated channels from each CD at a surveillance site to the local en route computer (2400 bps each). Three redundant channels are provided for backup, but a common DTG *and common modems at the surveillance site* serve both the primary and the backup channels (simplex).	Three dedicated channels from each CD-2 at a surveillance site to the local en route computer (2400 bps each). Three redundant channels are provided for backup. Separate modems at each end, and separate DTGs at the surveillance site are provided for the primary and the backup channels (simplex).	Same as Near Term except for some terminal radar sites equipped with a DABS sensor where four dedicated channels will interconnect the DABS processor to the local en route computer (4800 bps).	Four dedicated channels from each DABS processor at en route radar sites to a front-end processor at the local en route computer(48[illegible] bps).
b. Broadband Search and Beacon Data	FAA-owned Radar Microwave Link (RML) from each surveillance site to the local ARTCC, as backup for the digitized data (simplex).	NC	Deleted	NA

TABLE 9-2
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
7. DATA LINK-ARTCC	NA	NA	Up to three dedicated channels from some terminal DABS radar sites to a front-end processor at the local en route computer (4800 bps).	Up to three dedicated channels from each associated en route DABS radar site to a front-end processor at the local en route computer (4800 bps).
8. WEATHER RADAR -- ARTCC	Data transfer via 2400 bps dedicated channels from NWS weather radar sites to ARTCC	NC	Data transfer via one dedicated channel from nearest NEXRAD site to ARTCC (2400 bps - minimum) - (full duplex).	NC
9. ARTCC-FLIGHT SERVICE a. Non-Automated FSSs	Area B TTY Network - Transfer of IFR flight plan data from flight service stations to ABDIS switch (75 bps), then to ARTCC for entry into the en route computer (75 bps) (half duplex).	NADIN - Data transfer from FSS to NADIN concentrator (75 bps or 1200 bps), to NADIN switch (9600 bps), to NADIN concentrator (9600 bps), then to en route computer (up to 40 kbps) and vice versa (half duplex).	NA	NA

TABLE 9-2
(CONTINUED)

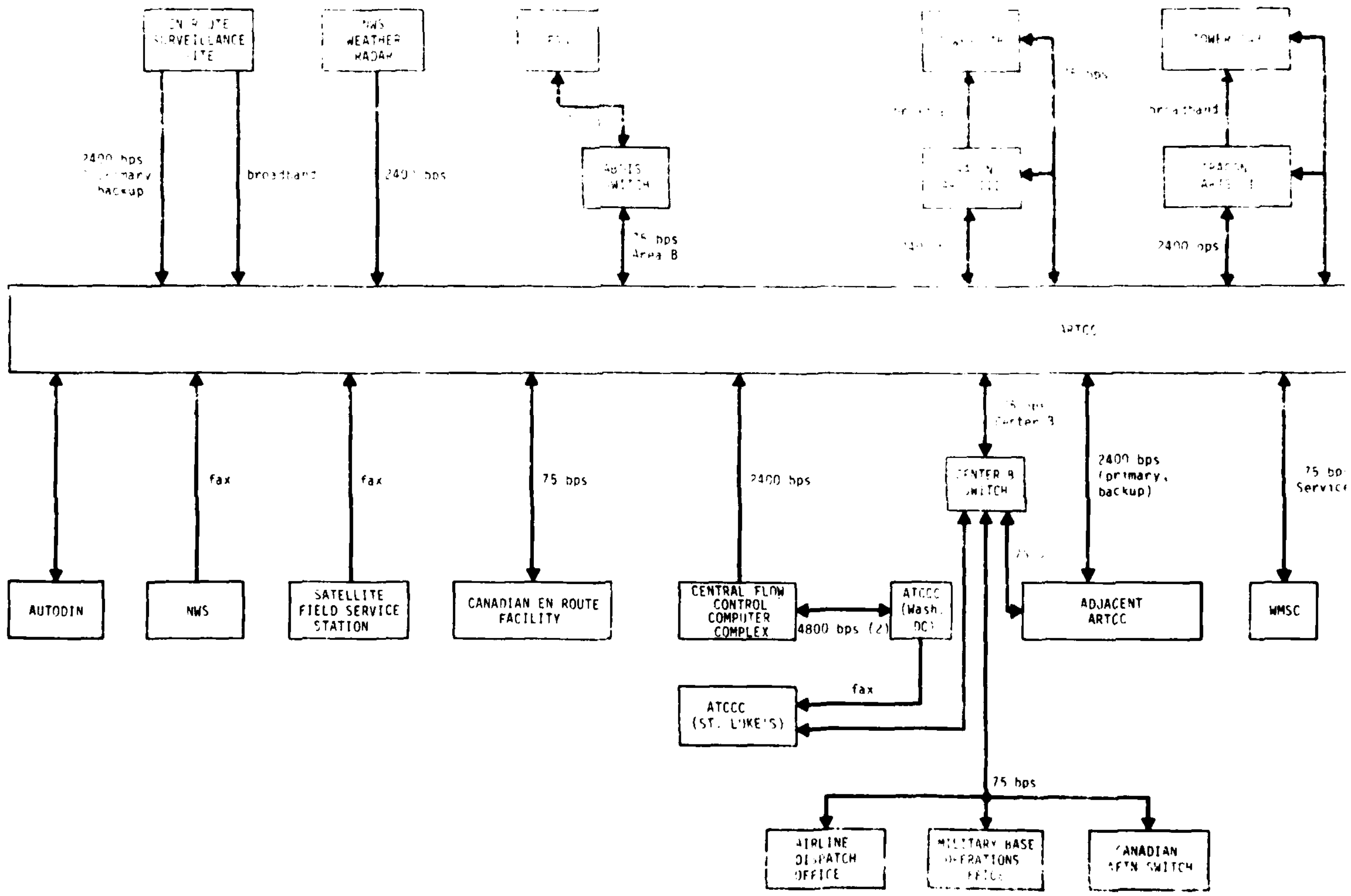
FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
b. Automated FSSs	NA	NADIN 1A - Data transfer from AFSS to FSDPS to NADIN concentrator (4800 bps), to NADIN concentrator (4800 bps), to en route computer (up to 40 kbps) and vice versa (half duplex).	NADIN Enhancement - Data transfer from AFSS to FSDPS, to NADIN concentrator (4800 bps), to another NADIN concentrator (4800 bps), to en route computer (up to 40 kbps) and vice versa, (half duplex).	NC
10. ARTCC-BASEOPS, CANADIAN EN ROUTE CENTERS AND AIRLINE DISPATCH OFFICES	Utility B TTY Network - Transfer of active IFR flight plans from BASEOPS, 3 Canadian En Route Centers, and Airline Offices, to an en route computer (75 bps) (half duplex).	NADIN - Data transfer from TTY or DTE station to NADIN concentrator (75 bps or 1200 bps), to NADIN switch (9600 bps), to NADIN concentrator (9600 bps), then to en route computer (up to 40 kbps), and vice versa (half duplex).	NC	NC

TABLE 9-2
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
11. CENTER-CENTER (INCLUDING FOREIGN ATC CENTERS)	Center B TTY Network and Switch - Interchange of flight plan data between centers on same loop(1 of 9) and between centers on *separate loops*, via switching capability at NATCOM (75 bps) (half duplex).	NADIN - Data transfer from ARTCC to NADIN concentrator (2400 bps), to NADIN switch (9600 bps), to NADIN concentrator (9600 bps), then to terminal in adjacent *ARTCC* (2400 bps).	NC	NC
12. NWS(NMC)-ARTCC	One dedicated telephone line to carry weather chart data from NMC to facsimile printer in each ARTCC.	NC	Deleted	NA
13. ARTCC-WMSC	Service A - Weather data and Request/Reply service from WMSC (75 bps) (half duplex).	NADIN - Data transfer from DTE to NADIN concentrator (2400 bps), to NADIN switch (9600 bps), to WMSC (4800 bps) and vice versa.	Data transfer same as for NADIN in Near-Term with exception of WMSC whose function has been consolidated with the AWP.	NC

TABLE 9-2
(CONCLUDED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
14. ARTCC-CFCCC	Movement data transmitted by ARTCC to one of five ARTCCs (2400 bps), then dedicated line to CFCCC (2400 bps).	NADIN-Data transfer from each ARTCC to NADIN concentrator (up to 40 kbps), to NADIN switch (9600 bps), then to CFCCC (4800 bps).	NC	NC
15. ATCCC (WASH D.C.) - ARTCC	Directives transmitted by ATCCC (Wash D.C) to ATCCC-St. Luke's (fax.), to center B switch (75 bps), to ARTCC (75 bps)	NADIN - Directives transmitted by ATCCC (Wash D.C.) to NADIN switch (4800 bps), to NADIN concentractor (9600 bps), then to ARTCC (up to 40 kbps).	NC	NC
16. SATELLITE FIELD SERVICE STATION - ARTCC	Dedicated telephone line to each of the 20 ARTCCs to carry facsimiles of NOAA satellite pictures.	NC	Digital facsimile of NOAA satellite pictures transmitted by SFSS to NADIN concentrator, to NADIN switch (9600 bps), to NADIN concentrator (9600 bps,), to ARTCC.	NC



NWS WEATHER RADAR
2400 bps (primary backup)
broadband
75 bps Area B
2400 bps
ARTCC
fax
fax
75 bps
2400 bps
2400 bps (primary, backup)
AUTODIN
NWS
SATELLITE FIELD SERVICE STATION
CANADIAN EN ROUTE FACILITY
CENTRAL FLOW CONTROL COMPUTER COMPLEX
4800 bps (2)
ADJACENT ARTCC
WMSC
ATCCC (ST. LUKE'S)
fax
75 bps
AIRLINE DISPATCH OFFICE
CANADIAN AFTN SWITCH

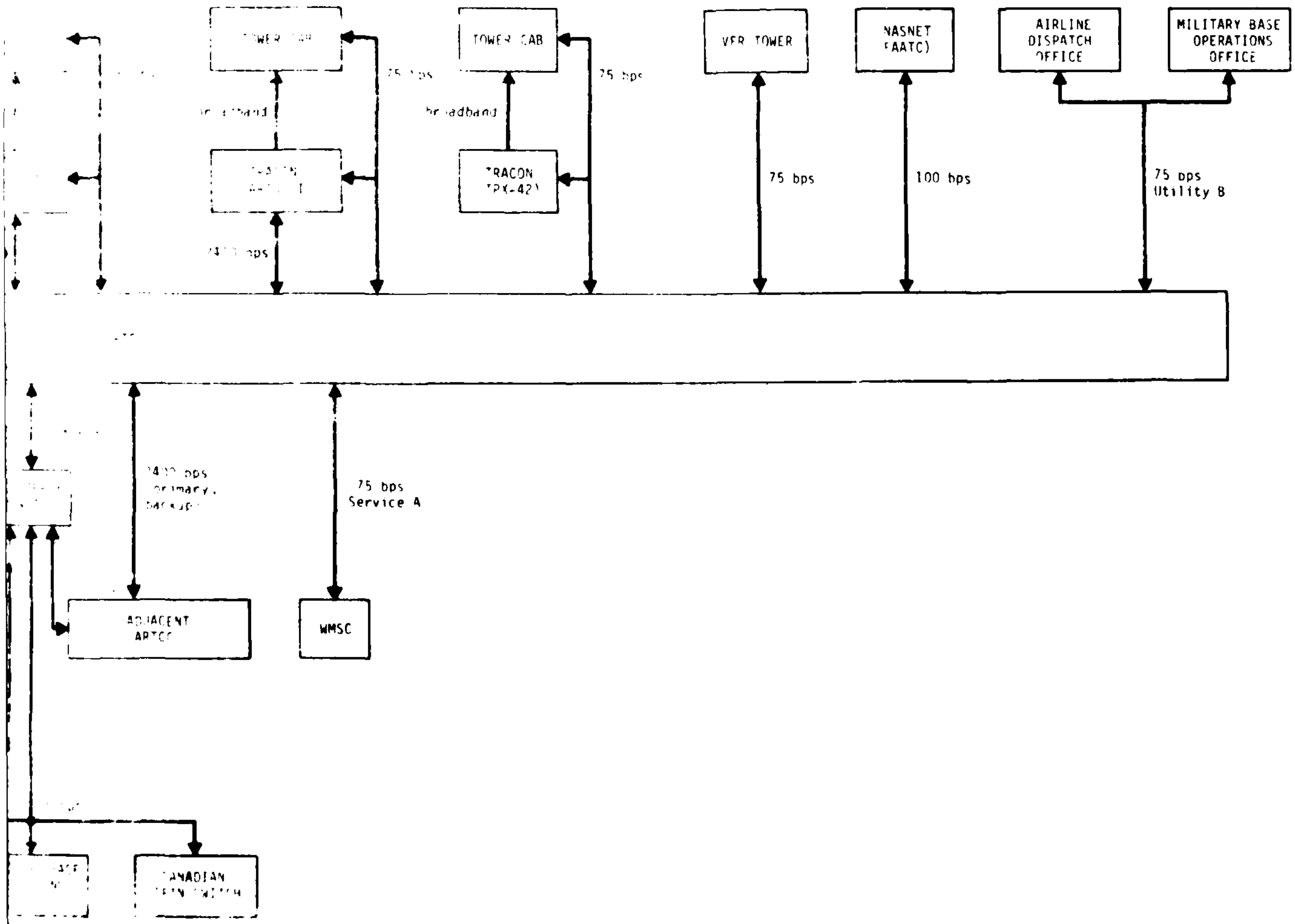
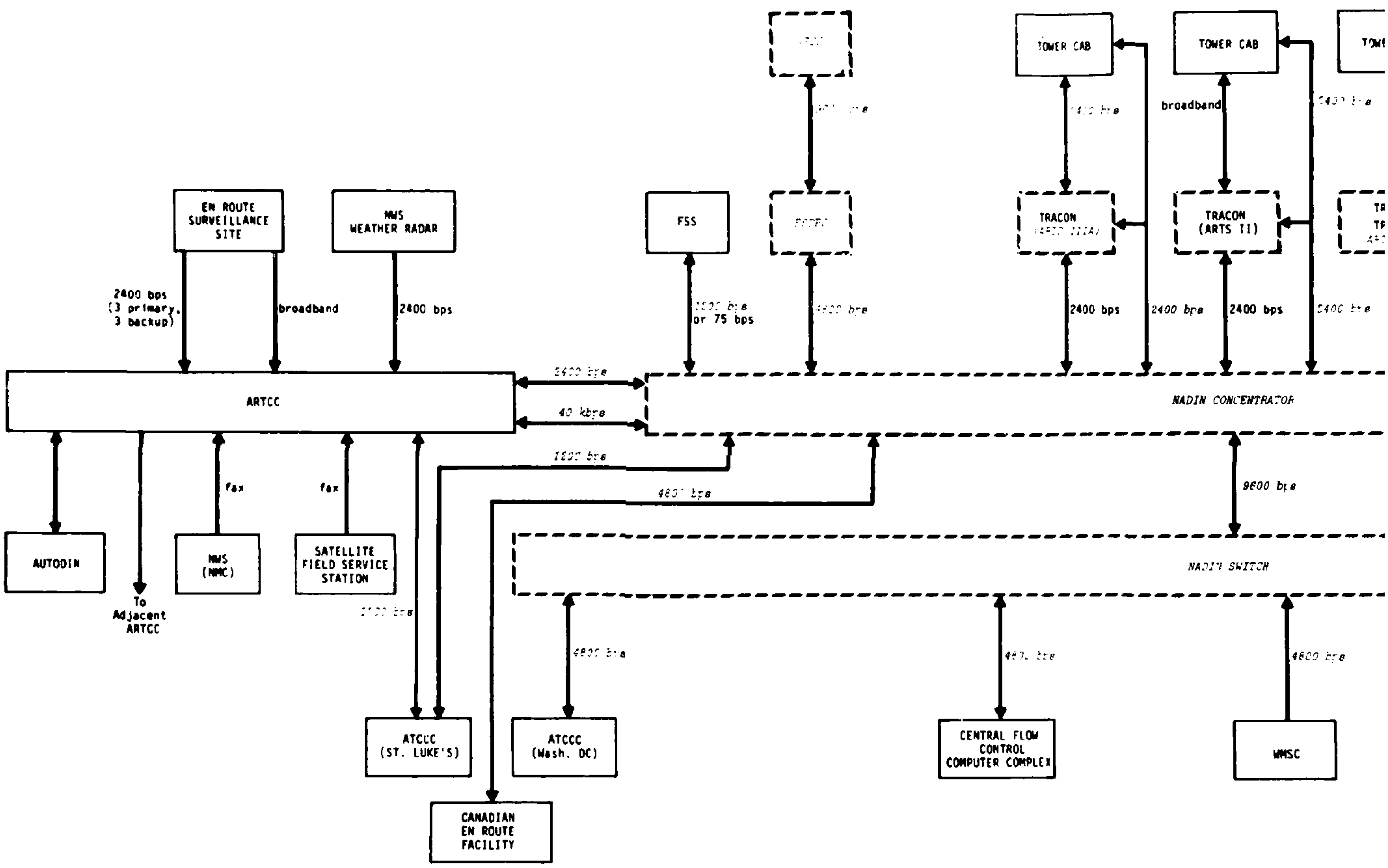


FIGURE 9-1
CURRENT EN ROUTE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

PRECEDING PAGE BLANK-NOT FILMED



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

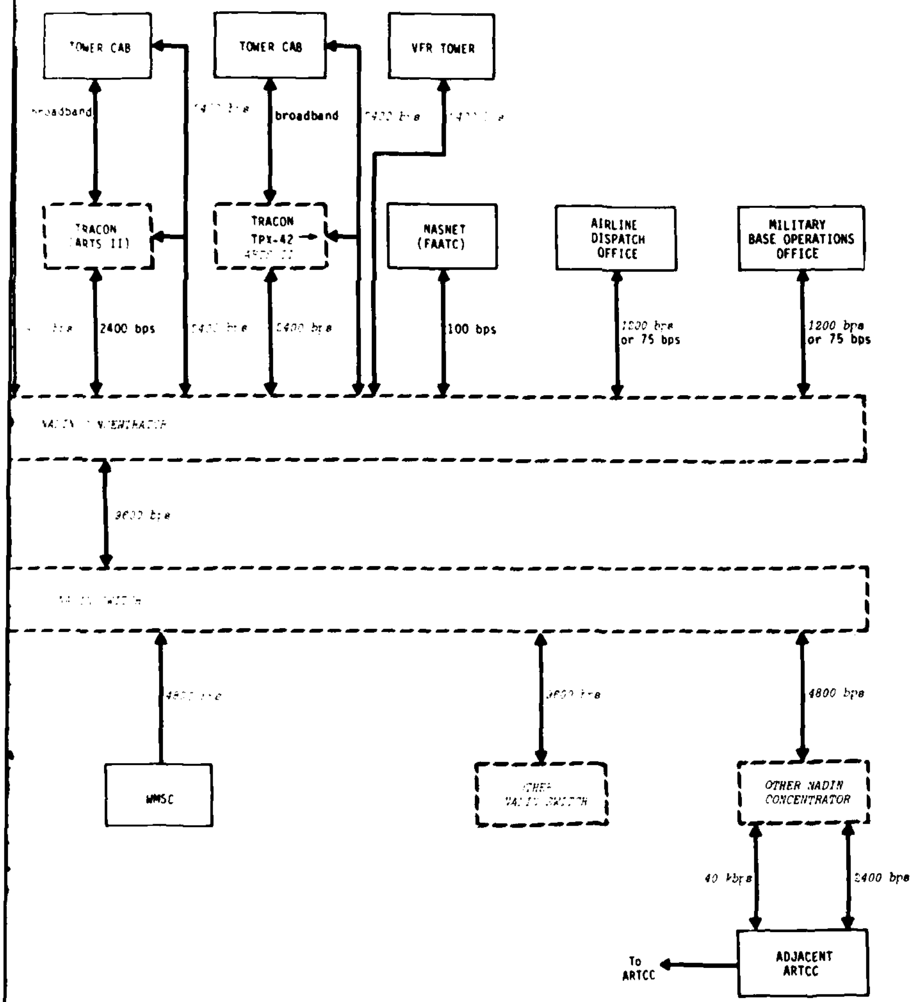
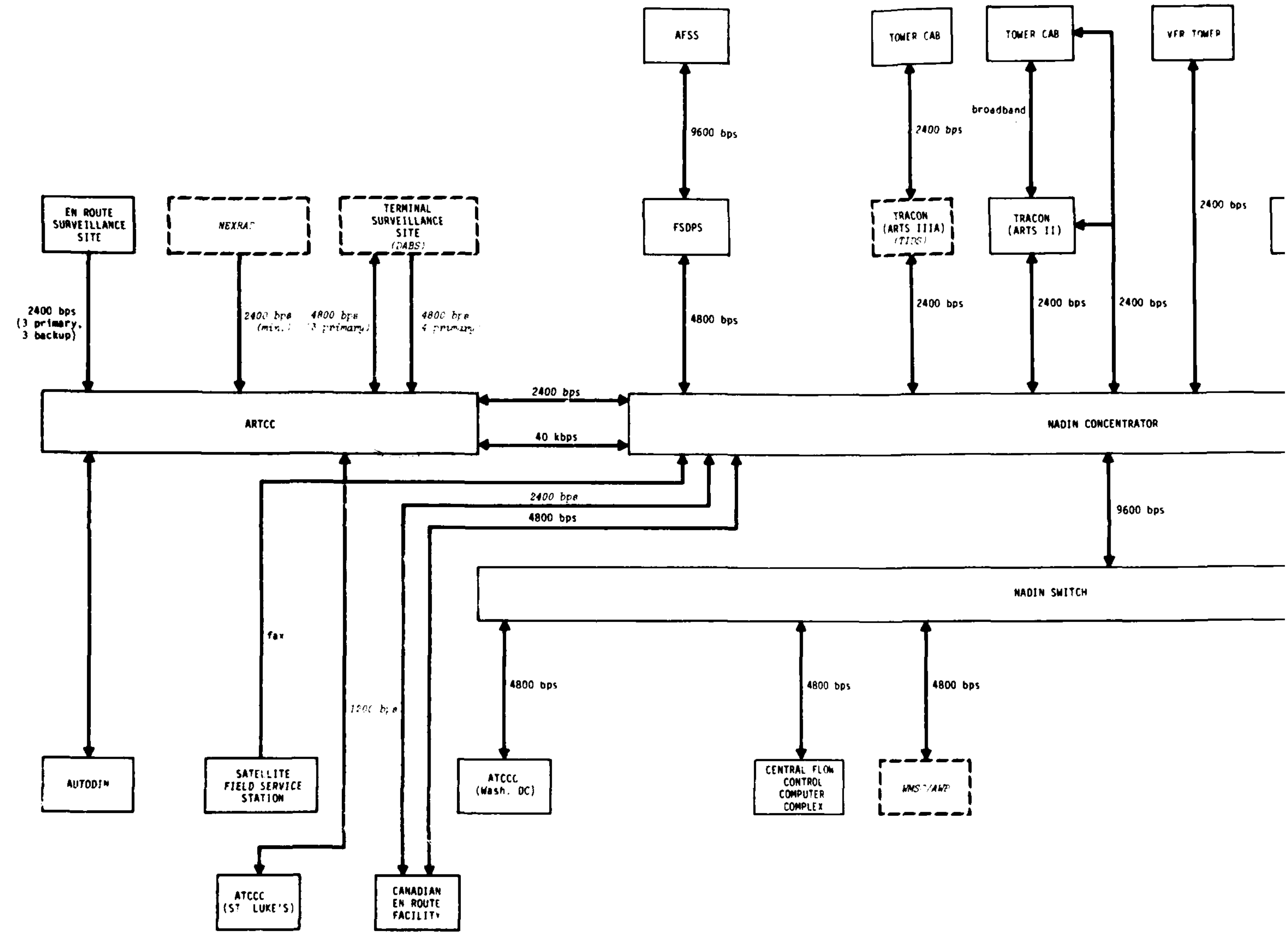
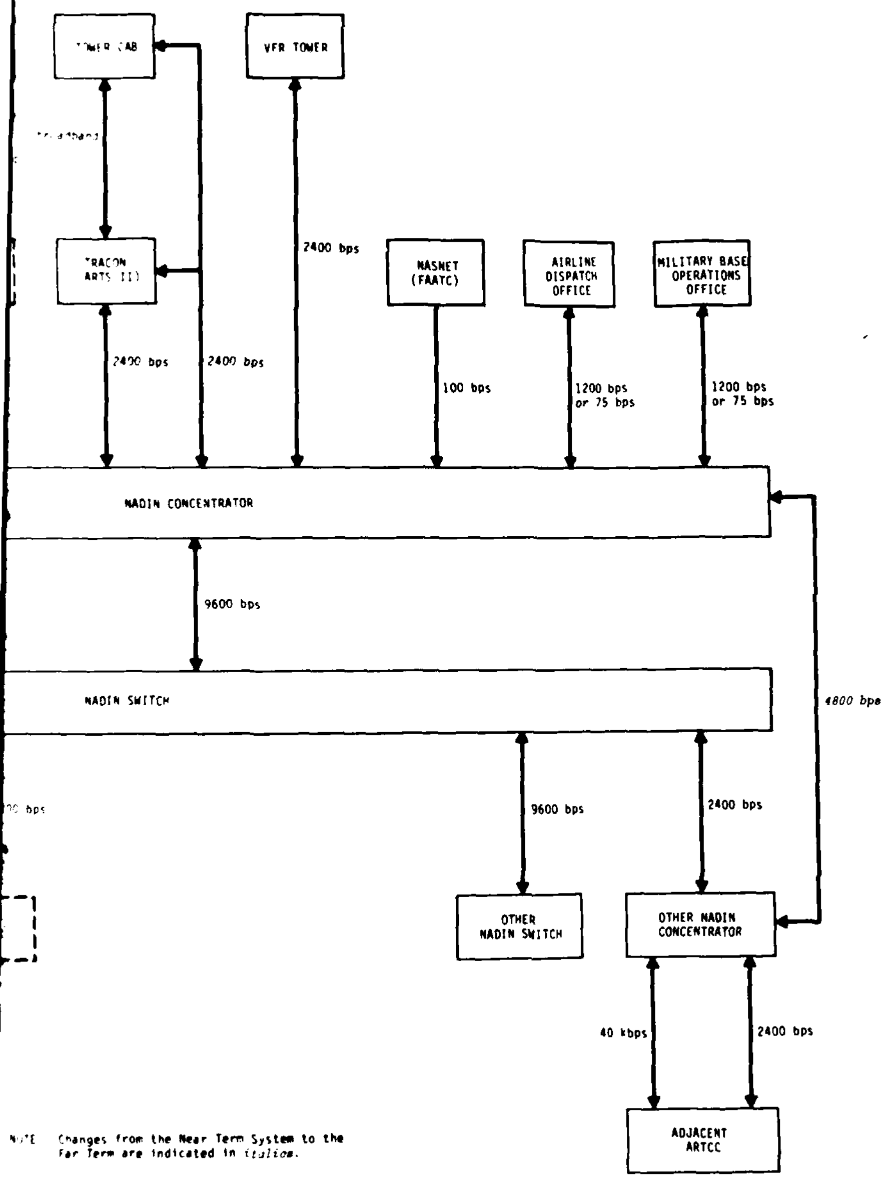


FIGURE 9-2
NEAR TERM EN ROUTE DATA COMMUNICATIONS
CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term System to the Far Term are indicated in *italics*.



NOTE Changes from the Near Term System to the Far Term are indicated in *italics*.

FIGURE 9-3
FAR TERM EN ROUTE COMMUNICATIONS
CONNECTIVITY DIAGRAM

2

PRECEDING PAGE BLANK-NOT FILMED

Current En Route Facilities

ARTCC interfacility computer-to computer data transmission is provided over a 2400 bps primary channel, and a 2400 bps redundant channel.

ARTCC to ARTS III (or ARTS II) interfacility computer-to-computer data transmission is provided over a 2400 bps channel (Reference 9-4). A low speed FDEP circuit is provided to print flight strips in the tower and TRACON.

No computer-to-computer interface is provided between the ARTCC (9020) and the TPX-42 equipped TRACON since the TPX-42 is basically a hard-wired system, with very little computing capability. A low speed circuit from an ARTCC is, however, provided for printing flight strips on FDEP equipment in the TPX-42 TRACONs and towers. Low speed circuits from an ARTCC are also provided for printing flight strips on FDEP equipment in VFR towers.

Digitized search and beacon data from the common digitizer are transmitted from surveillance sites to an ARTCC via three 2400 bps channels. Three identical channels are provided for redundancy.

Weather radar data from NWS weather radar sites are transmitted to the ARTCC via a dedicated 2400 bps channel in the Current time period.

Teletypewriter service for transmitting flight plans, flight movement data and administrative messages is provided on three

different networks; Area B, Utility B and Center B. The first two networks are connected directly to the 9020 computer in the ARTCC. The Center B network has a terminal in the ARTCC, but is not connected to the 9020 computer.

Flight movement reports are transmitted to the Central Flow Control Computer Complex (CFCCC) via one of five ARTCCs (equipped with store and forward capability) which relays these messages to the CFCCC from other ARTCCs. Flight movement directives are transmitted from the ATCCC (Washington D.C.) to the ATCCC (St. Luke's) in Jacksonville, Florida, via a dedicated facsimile circuit. These directives are then transmitted from ATCCC (St. Luke's) to the Center B switch (NATCOM) where they are distributed to the appropriate ARTCCs via the Center B network.

Each ARTCC has a facsimile printer for copying weather charts from the National Meteorological Center (NMC). Transmission is over a single dedicated voiceband telephone line.

Facsimilies of NOAA satellite pictures are transmitted to each ARTCC via dedicated telephone facilities from Satellite Field Service Stations (SFSS).

The WMSC provides Weather data and request/reply service to each ARTCC via a dedicated 2400 bps circuit.

Near Term En Route Facilities

NADIN Enhancements will be introduced in the Near Term to provide all flight plan and flight strip data transmission

between ARTCCs and FDIO (Flight Data Input/Output) terminals located at ARTS IIIA, ARTS II, ARTS II-like replacement for TPX-42 and VFR Tower facilities, via NADIN. Flight plan and handoff data between ARTCCs, and between ARTCCs and all ARTS IIIA and ARTS II computers will continue to be transmitted via dedicated transmission facilities. The TPX-42 terminal equipment will be replaced with ARTS II-like equipment in the Near Term.

All three teletypewriter networks (Area B, Utility B and Center B), will be replaced with transmission and switching by NADIN in the Near Term. Transmission facilities for the FAATC's NASNET system will also be provided by NADIN in the Near Term.

For surveillance data, the CD-2 is introduced in the Near Term, to replace the original CD. The CD-2 provides completely redundant paths from the Data Transmission Groups (DTGs) at the surveillance site through the modems at each end, and the redundant transmission facilities. The broadband radar service will continue to be used for backup in the Near Term.

Weather radar data will continue to be transmitted from the NWS weather radar sites via dedicated channels in the Near Term.

The facsimile service from NMC to a printer in each ARTCC will remain the same in the Near Term as in the current system.

The Service A weather data and request/reply service from the WMSC will be replaced with transmission and switching via NADIN in the Near Term.

Early in the Near Term time period, the five (5) store-and-forward ARTCCs and the dedicated transmission facilities from the other ARTCCs to these five ARTCCs will be replaced with dedicated transmission facilities from each ARTCC to the CFCCC for the transfer of flow movement data. Later during the Near Term, a NADIN Enhancement will also provide transmission and switching to replace the dedicated facilities from the twenty (20) ARTCCs to the CFCCC for flow control data transmission. Flow control directives from the ATCCC (Washington D.C.) will also be transmitted to each of the ARTCCs via NADIN in the Near Term.

NOAA satellite pictures from SFSSs will continue to be transmitted to each of the ARTCCs via facsimile over dedicated tranmission facilities.

Far Term En Route Facilities

NADIN Enhancements will be introduced in the Far Term to provide all computer-to-computer transmission between ARTCC computers, and between ARTCC computers and all ARTS IIIA and ARTS II TRACON computers via NADIN facilities for active flight plan and handoff data transfer. At some ARTS IIIA locations, TIDS will replace the FDIO subsystem, introduced in the Near Term, and act as a front-end processor for the ARTS IIIA processor in the Far Term. NADIN will continue to provide the interface to FDIO terminal equipment in all other facilities as in the Near Term.

The three teletypewriter networks (Area B, Utility B and Center B) and the FAATC's NASNET, which were replaced with NADIN in the Near Term, remain configured as in the Near Term.

Weather charts provided from the NMC via a dedicated facsimile circuit to each ARTCC will be replaced in the Far Term. These weather charts will be provided by the WMSC/AWP to the CWSU at the ARTCC via NADIN in the Far Term.

Weather radar data presently furnished by the NWS weather radar sites will be replaced with weather radar data obtained from NEXRAD. A 2400 bps (minimum) dedicated data channel will be used for transmitting this weather data.

Following the introduction of the dual common digitizer (CD-2) at en route surveillance sites, enhancements to the Direct Access Radar Channel (DARC) equipment at the ARTCC and the availability of acceptable digital weather radar data, broadband search and beacon data currently transmitted via the FAA-owned RML system will be eliminated as backup in the Far Term.

Terminal Discrete Address Beacon Systems (DABS) will be introduced at some ARTCC facilities in the Far Term. Transmission from the DABS site to the en route ARTCC will be via up to four (4) dedicated channels for surveillance data. Up to three (3) communication channels will be provided from those same DABS sites for transfer of ATARS messages between the ARTCC and the DABS site.

Weather data and Request/Reply service provided by the WMSC to the ARTCC will be provided by the consolidated WMSC/AWP in the Far Term.

NOAA Satellite pictures will be transmitted by digital facsimile to the ARTCCs via NADIN. Due to the high data transmission rate

required for digital facsimile, this requirement may impose a severe technical requirement on the NADIN system.

Potential And Longer Range En Route Facilities

Several potential and longer range improvements are planned for en route facilities. ARTCC to ARTS II site transmission will be the same as in the Far Term time period with the exception of the interface to the ARTS II computer which may be via the Terminal Information Display System (TIDS). TIDS may replace the FDIO Subsystem and act as a front-end processor for the ARTS II processor. Transmission from ARTCC to VFR Towers associated with ARTS IIIA TRACONs will also be via the TIDS system.

The Discrete Address Beacon System (DABS) will be introduced in en route surveillance sites following the en route ATC computer replacement. Transmission from the en route DABS site to the ARTCC will be via up to four (4) dedicated 4800 bps channels.

Data link communications between surveillance sites and ARTCCs will also be introduced as a potential and longer range en route facility improvement. Up to three (3) dedicated 4800 bps channels will be provided between the DABS processor and a front-end processor at the ARTCC.

Data communications are planned between Maintenance Processor Systems (MPS) which will be introduced in the Near and Far Term time periods. These communications are not fully defined at this time. However, NADIN is expected to carry this traffic in the future.

9.1.1.2 TRACON/Tower Facilities Improvements

The TRACON/Tower, or terminal, data communications are comprised of the following services; TRACON to ARTCC, TRACON to TRACON, surveillance sites to TRACON, automated TRACON to towers and ARTCC data to FDEP equipment in TRACONS. Some basic assumptions which were used in describing the terminal data communications are listed in Table 9-3. The descriptions of data communications facilities used during the three periods of interest, Current, Near Term and Far Term, are contained in Table 9-4. An illustration of the configuration for each of the three time periods is shown in Figures 9-4, 9-5, and 9-6. Clarifying information is included in the next three subparagraphs.

Current TRACON/Tower Facilities

The ARTCC to TRACON data transfer is described in Section 9.1.1.1, En Route Facilities Improvements, for both computer-to-computer data transfer, as well as low-speed flight strip data transfer over FDEP circuits.

TRACON to TRACON data transfer is provided over some transmission paths by what is known as "tower en route" control. Data is relayed through one or more en route computers. No additional transmission lines are required as the normal ARTS III to ARTCC and ARTCC to ARTCC channels are used for tower en route control.

Surveillance and beacon data are transmitted as broadband data to each type of TRACON (ARTS III, ARTS II and TPX-42).

TABLE 9-3
ASSUMPTIONS FOR TRACON/TOWER FACILITIES DATA COMMUNICATIONS

1. Tower en route operation will continue to occur between adjacent terminals operating under the same or adjacent centers.

2. DABS will be implemented at ARTS IIIA and ARTS II sites in the Far Term.

3. ARTS IIIA and ARTS II TRACONs will receive digitized surveillance data from terminal surveillance sites (DABS) in the Far Term.

4. Transfer of digitized surveillance data to an ARTS IIIA TRACON in the Far Term will be via four 4800 bps lines.

5. Broadband surveillance data will not be used when digitized surveillance data is available.

6. The ARTS IIIA and ARTS II TRACONs, which utilize digitized surveillance data, will have digital displays or will use video reconstitutors with time shared analog/digital displays.

7. In the Far Term, ARTS IIIA towers will have Tower Cab Digital Displays (TCDDs).

8. In the Far Term, DABS data link capability will be available at ARTS IIIA and ARTS II sites equipped with DABS.

9. Three 4800 bps channels will be provided from a terminal surveillance site to ARTS IIIA and ARTS II sites for data link.

10. No redundancy will be provided for the data channels from surveillance sites to terminals.

11. All TRACONs (ARTS IIIA, ARTS II and TPX-42) may have satellite towers.

12. Digitized weather radar (NEXRAD) will be provided in the Far Term for ARTS IIIA only.

TABLE 9-4
TRACON/TOWER FACILITIES - DATA COMMUNICATIONS
IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
1. ARTS III TRACONs ARTCC			See Table 9-2 Item 2	
2. ARTS II TRACONs ARTCC			See Table 9-2 Item 3	
3. TPX-42 TRACONs - ARTCC			See Table 9-2 Item 4	
4. VFR TOWER - ARTCC			See Table 9-2 Item 5	

NC = No Change in Current Plans
NA = Not Applicable

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
5. ARTS III - ARTS III a. Flight Plan and Handoff Data	Relay through an en route computer to transfer data between two ARTS III computers. The data transfer is over dedicated channels from the sending ARTS III computer to the en route computer (2400 bps) where data is processed and then transmitted to the receiving ARTS III computer (2400 bps) (full duplex).	NC	NADIN Enhancement - Data transfer from ARTS III A computer to NADIN concentrator (2400 bps), to ARTCC (40 Kbps) where data is processed, to NADIN concentrator (40 Kbps), then to another ARTS III computer (2400 bps) via TIDS (full duplex).	
6. TERMINAL SURVEILLANCE SITES- ARTS III TERMINALS a. Broadband Surveillance and Beacon Data	FAA-owned Radar Microwave Link (RML) or coax cable from each and surveillance site to the associated TRACON for transmission of broadband surveillance and beacon data.	NC	Deleted	

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
b. Digitized Surveillance Data, Weather Radar for and Beacon Data	NA	NA	Four dedicated circuits (4800 bps) from each DABS site to a TRACON, transfer of digitized surveillance , weather and beacon data (full duplex).	
c. Data Link (Including ATARS)	NA	NA	Three dedicated channels (4800 bps) from each terminal surveillance site (DABS) to an ARTS III A computer via TIDS for data link (full duplex).	
7. NEXRAD-ARTS IIIA TRACONs	NA	NA	Dedicated circuit (2400 bps minimum) from NEXRAD site to transfer weather data to TRACON	

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
8. ARTS III TERMINAL-TOWERS a. Surveil-lance Data	Data for the tower BRITE displays at towers are transmitted from the TRACON over a RML or a coax cable to tower (simplex).	One dedicated circuit (2400 bps) from the TRACON to the Tower Cab Digital Displays (TCDD) at a tower.	NC	
b. Weather Radar Data	NA	NA	Dedicated line (2400 bps - minimum) from ARTS IIIA TRACON to tower to transfer weather radar data to the TCDD.	
c. Airport Weather Sensor Data	Dedicated line (s) from tower to associated TRACON to transfer airport weather data.	NC	NC	

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
9. TERMINAL SURVEILLANCE SITES - ARTS II TERMINALS a. Broadband Surveillance and Beacon Data	FAA-owned RML or coax cable from each airport surveillance site to the associated TRACON for transmission of broadband surveillance and beacon data.	NC	Deleted	NC
b. Digitized Surveillance Data, Weather Radar and Beacon Data	NA	NA	Four dedicated circuits (4800 bps) from each site to a TRACON for transfer of digitized surveillance data, weather data and beacon data (full duplex).	NC
c. Data Link (Including ATARS)	NA	NA	Three dedicated channels (4800 bps) from each terminal surveillance site (DABS) to an ARTS II computer via TIDS for data link (full duplex).	NC

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
10. ARTS II TERMINALS-TOWERS a. Surveillance Data	Data for the tower BRITE displays at towers are transmitted from the TRACON over an RML or a coax cable (simplex).	NC	NC	One dedicated circuit (2400 bps) from the TRACON to the Tower Cab Digital Displays (TCDD) at a tower.
b. Weather Radar Data	NA	NA	NA	One dedicated circuit (2400 bps) from the TRACON to the Tower Cab Digital Displays (TCDD) at a tower
c. Airport Weather Sensor Data	Dedicated line(s) from tower to associated TRACON to transfer airport weather data	NC	NC	NC

TABLE 9-4
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
11. SURVEILLANCE SITES - TPX-42 TERMINALS Broadband Surveillance and Beacon Data	FAA-owned RML or coax cable from each airport surveillance site to the associated TRACON for transmission of broadband surveillance and beacon data.	TPX-42 Terminals will be replaced with ARTS II-like Terminals.	NC	NC
12. TPX-42 TERMINAL TOWERS Surveillance Data	Data for the tower BRITE displays at towers are transmitted from the TRACON over RML or a coax cable (simplex).	NC (TPX-42 Terminals will be replaced by ARTS II-like terminals.)	NC	BRITE displays in towers will be replaced with Tower Cab *Digital Displays* (TCDD). One dedicated (2400 bps) circuit from the TRACON to the tower.
13. TERMINAL DABS - TERMINAL DABS	NA	NA	One dedicated channel (4800 bps) from a DABS site to each adjacent DABS site for ATARS multi-site coordination messages and data link failure messages. (full duplex).	Same as Far Term except transmission will be via NADIN.

TABLE 9-4
(CONCLUDED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)	POTENTIAL AND LONGER RANGE IMPROVEMENTS
14. RBX - ARTS IIIA TRACONs	NA	*One dedicated channel* (4800 bps) from a RBX site to an ARTS IIIA computer for transmission of BCAS desensitization messages and BCAS controller advisory messages. (full duplex).	NC	NC
15. *VOR - TOWER* CAB/VFR TOWER	*One dedicated channel* for transmission of VOR/VORTAC status information (simplex).	NC	NC	NC
16. ATCCC (Wash. DC) - ATCTs	NA	NADIN - *Directives* transmitted by ATCCC (Wash. D.C.) to NADIN switch (4800 bps), to NADIN concentrator (9600 bps), to ATCCC - St. Luke's (4800 bps) then to 17 ATCTs via NADIN.	NC	NC
17. *JAWOS -TRACONs/* Towers	NA	NA	Dedicated channels from JAWOS sites to TRACONs/ Towers for transmission of local weather data	NC

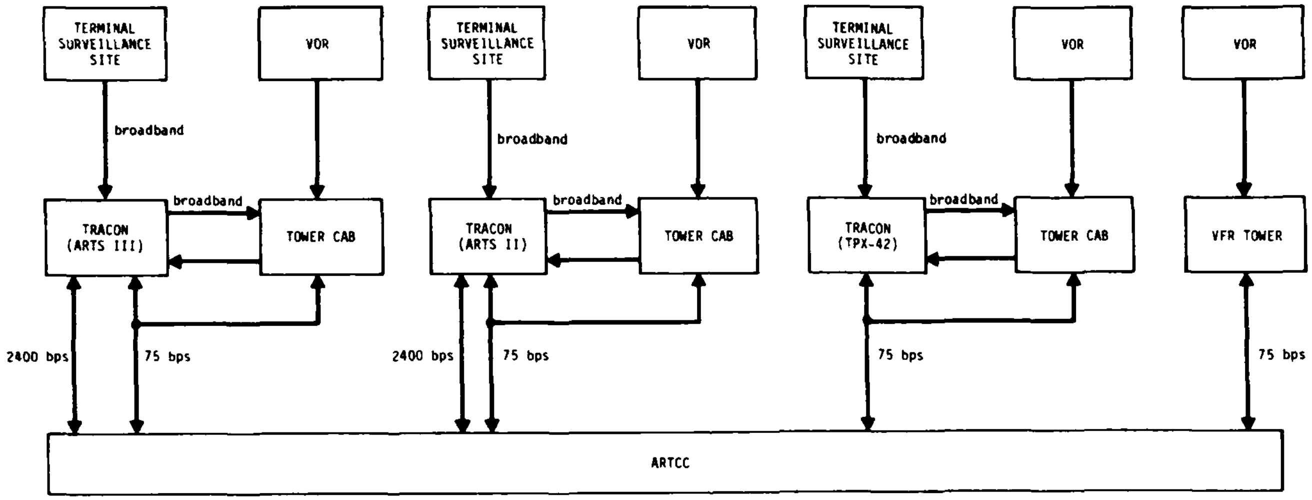
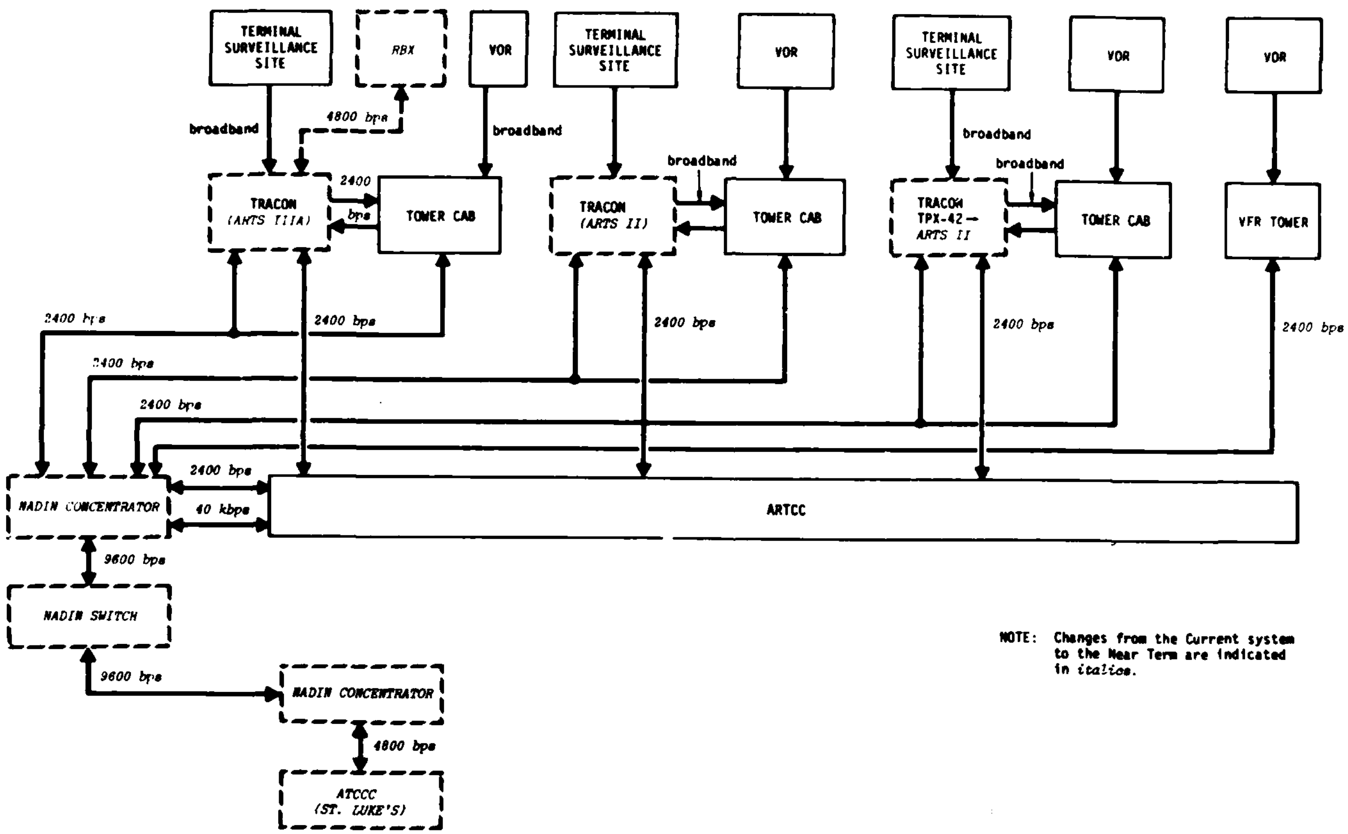
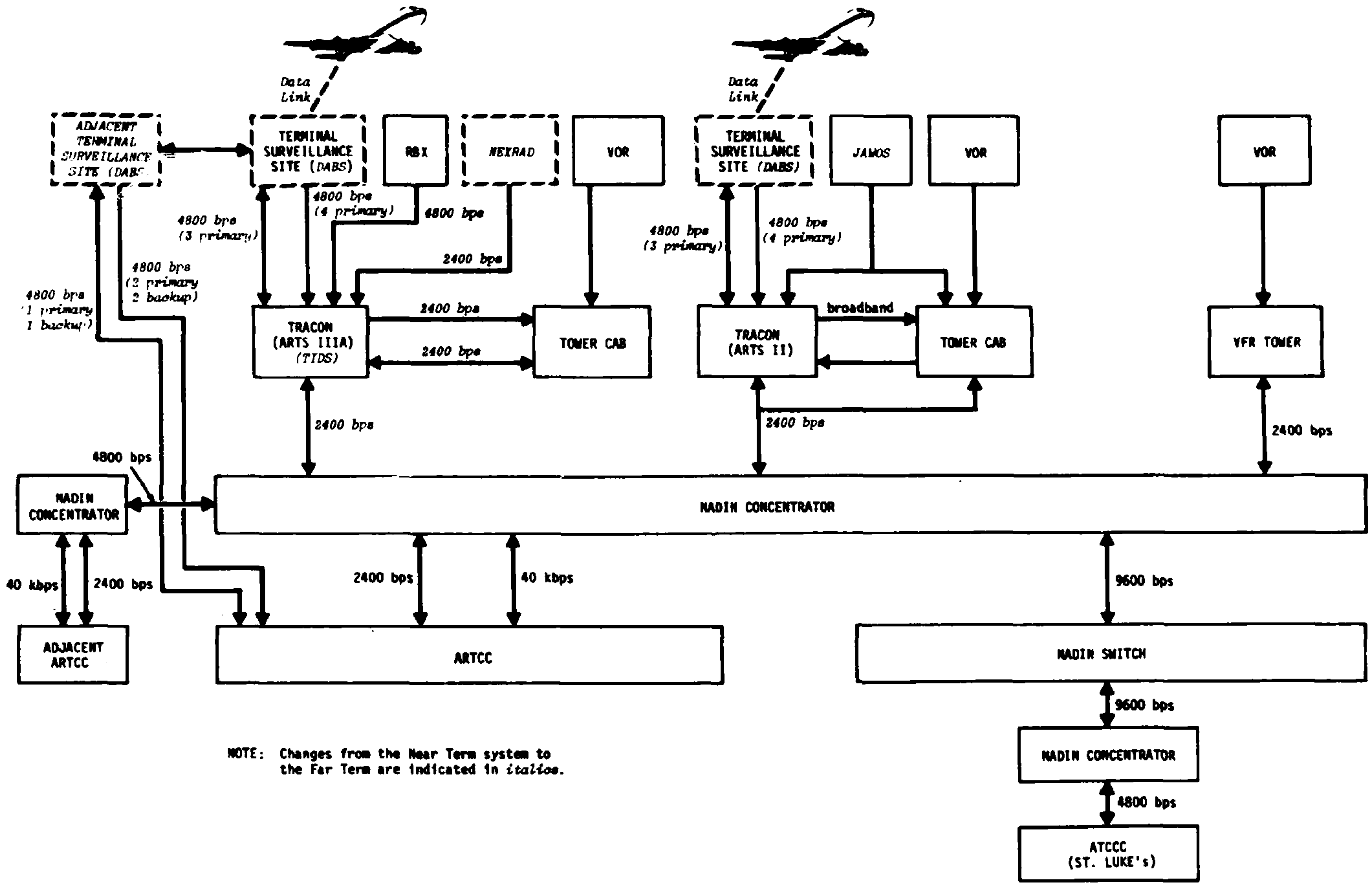


FIGURE 9-4
CURRENT TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 9-6
NEAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 9-6
FAR TERM TRACON/TOWER DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

Data for BRITE displays at towers are transmitted from each of the three different types of TRACONs (ARTS III, ARTS II and TPX-42) as broadband data.

VOR/VORTAC status information is transmitted to the tower facilities over dedicated transmission facilities.

Near Term TRACON/TOWER Facilities

The ARTCC to TRACON data transfer is described in Section 9.1.1.1, En Route Facilities Improvements.

TRACON to TRACON data transfer will continue to be provided over some transmission paths by "tower en route" control in the Near Term.

Surveillance and beacon data continue to be transmitted to ARTS IIIA and ARTS II sites as broadband data.

Towers associated with ARTS IIIA TRACONs will be equipped with the Tower Cab Digital Displays (TCDD) in the Near Term. A dedicated 2400 bps circuit will be used to transfer display data from an ARTS IIIA TRACON to these towers. ARTS II towers will continue to use BRITE displays. Broadband data will be transmitted to the BRITE displays from the ARTS II sites.

BCAS desensitization and controller advisory messages will be transmitted over a 2400 bps dedicated channel from ARTS IIIA sites to RBX sites in the Near Term.

Flow control directives from the ATCCC (Washington D.C.) will be

transmitted to DTEs in the 20 ARTCCs and 17 high activity ATCTs via NADIN in the Near Term.

Far Term TRACON/TOWER Facilities

Data trnsmission between ARTCCs and TRACONs is described in Section 9.1.1.1, En Route Facilities Improvements.

TRACON to TRACON data transfer, including concentration and switching, will be provided along some routes by "tower en route" control. Concentration and switching are provided by NADIN in the Far Term. However, the NADIN interface to ARTS IIIA terminals in Far Term will be via TIDS.

Terminal DABS will be introduced in the Far Term at ARTS IIIA and ARTS II sites. Digitized surveillance and beacon data will be transmitted from the DABS surveillance sites to the ARTS IIIA and ARTS II sites via up to four dedicated 4800 bps circuits. Adjacent terminal DABS sites will also be interconnected in the Far Term via a dedicated transmission facility for the interchange of ATARS multi-site coordination messages and data link failure messages.

Data link service, including ATARS, will be provided from the terminal DABS processor to the ARTS IIIA and ARTS II processors. Up to three (3) dedicated 4800 bps channels are used for transmission of data link communications data.

In the Far Term, towers associated with an ARTS IIIA site will receive not only digital aircraft surveillance data, but also digital weather radar data via a dedicated 2400 bps channel.

Towers associated with ARTS II and TPX-42 replacement facilities continue to use BRITE displays in the Far Term. Broadband data will be transmitted to the BRITE displays.

BCAS desensitization and controller advisory messages will continue to be sent from ARTS IIIA sites to RBX sites, as in the Near Term.

NEXRAD weather radar data are provided to the ARTS IIIA TRACONs over a dedicated 2400 bps data channel in the Far Term.

Dedicated channels are provided from JAWOS sites to TRACONs and towers for the transmission of local weather data.

Potential and Longer Range Terminal Facilities

Tower cab digital displays (TCDD) may be introduced at towers associated with ARTS II TRACON sites in the 1990s. A dedicated 2400 bps channel will be used to transmit tower display data to the TCDD from the ARTS II TRACON. Another dedicated 2400 bps channel will be used to transmit weather radar data to the TCDDs.

9.1.1.3 ATCCC Improvements

The Air Traffic Control Command Center (ATCCC), (Reference 9-1), dat. communications are comprised primarily of the following services: ARTCC to Central Flow Control Computer Complex (CFCCC), CFCCC to ATCCC (Washington D.C.), ATCCC (Washington D.C.) to ATCCC (St. Luke's, Jacksonville, Florida), ATCCC (St. Luke's) to ARTCC and NWS to ATCCC. Some basic assumptions which were used in describing the ATCCC data communications are listed

in Table 9-5. Descriptions of the data communications facilities for the three periods of interest, Current, Near Term and Far Term are contained in Table 9-6.

Illustrations of the configurations for the Current and Near Term time periods are shown in Figures 9-7 and 9-8. Changes in the ATCCC configuration for the Far Term have not been defined. Clarifying information is contained in the following three subparagraphs.

Current ATCCC Facilities

Flow control flight movement information is provided to the CFCCC through five selected ARTCCs with store and forward capability. A dedicated 2400 bps channel is provided from each of the five ARTCCs to the CFCCC. Flow control data from the remaining 15 ARTCCs are transmitted to these five ARTCCs, using the normal ARTCC-ARTCC data channels. This flow control data is then relayed to the CFCCC.

Flow control flight movement data is provided to the ATCCC (Washington D.C.) from the CFCCC via two dedicated 4800 bps channels. The ATCCC located in Washington D.C. transmits flight movement directives to the ATCCC located in the St. Luke's facility in Jacksonville, Florida, via facsimile. This flow control information is then transmitted from ATCCC (St. Luke's) to the AFTN/Center B switch at NATCOM over the AFTN network. The Center B network is then used to transfer flow control information to each of the ARTCCs. Flow control information to FSSs is sent via the Area B network.

TABLE 9-5
ASSUMPTIONS FOR ATCCC FACILITY DATA COMMUNICATIONS

1. The current transfer of flow control information from the ATCCC (Washington, D. C.) to ARTCCs accomplished by Center B and AFTN will be replaced by NADIN in the Near Term.

2. The current CFCCC interface with the ATCCC (Washington, D.C.) over two dedicated 4800 bps lines will be replaced by NADIN in the Near Term.

3. Emergency Operating Facilities in Martinsburg, West Virginia and at the Atlanta ARTCC will serve as backup to the ATCCC (Washington, D.C.). These facilities will not be fully operational until the Near Term.

TABLE 9-6
ATCCC FACILITY - DATA COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
1. ARTCC-CFCCC	One dedicated circuit (2400 bps) from CFCCC to each of five selected ARTCCs for transfer of flow control messages to the CFCCC NOTE: Transfer of flow control messages from the remaining 15 ARTCCs to the five ARTCCs which interface with the CFCCC is over the normal center-to-center data channels.	NADIN - Data transfer from each of the ARTCC en route computers to NADIN concentrator (up to 40 kbps), to NADIN switch (9600 bps), to CFCCC and vice versa.	NC
2. CFCCC - ATCCC (Wash. D.C.)	Two dedicated circuits (4800 bps each) for transfer of flow control messages from CFCCC to ATCCC (full duplex).	NADIN - Data transfer from CFCCC computer to NADIN switch (4800 bps), then to ATCCC (Wash. D.C.) (4800 bps) and vice versa (full duplex).	NC
3. ATCCC (Wash. D.C.)-ARTCCs (17 ATCTs) Flight Movement Directives	Data transfer of flow control directives from ATCCC (Wash. D.C.) to ATCCC - St. Luke's (facsimile) to AFTN Switch NATCOM (75 bps), to Center B Switch, to ARTCC (75 bps).	NADIN - Data transfer from one of several terminals at ATCCC to NADIN switch (4800 bps), to NADIN concentrator (9600 bps), to a terminal at ATCCC - St. Luke's (4800 bps), then to ARTCC terminal (2400 bps), 9020 computer (up to 40 kbps). or to ATCT (1200 bps) via NADIN.	NC

TABLE 9-6
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
4. Emergency Operating Facility - ARTCC Flight Movement Directives	NA	NADIN - Data transfer of flow control directives from EOF to ATCCC - St. Luke's (dial-up, 4800 bps), to NADIN concentrator (4800 bps), to NADIN switch (9600 bps), to NADIN concentrator (9600 bps), and then to ARTCC terminal (2400 bps), 9020 computer (up to 40 kbps) or to ATCT (1200 bps).	NC
5. NWS-ATCCC (Wash. DC)- a. Weather Radar	Three dial-up telephone lines to carry data from 37 radar sites to a facsimile terminal in the ATCCC (simplex).	NC	NC
b. Weather Charts	Facsimile circuit to carry charts of upper air conditions to ATCCC from NMC (simplex).	NC	NC
c. Satellite Maps	Dedicated telephone line to carry satellite pictures to ATCCC from Satellite Field Service Station.	NC	NC

TABLE 9-6
(CONCLUDED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
6. ATCCC (Wash. D.C.)-FSS (AFSS)	Area B TTY Network (75 bps) for transfer of flow control directives to various FSSs (half duplex).	NADIN - Data transfer from one of several terminals at ATCCC to NADIN switch (4800 bps), to NADIN concentrator (9600 bps) then to FSS (75 bps or 1200 bps) (half duplex), or to AFSS via FSDPS.	Data transfer from one of several terminals at ATCCC to NADIN concentrator (4800 bps), to NADIN concentrator (9600 bps) to FSDPS (4800 bps), to AFSS (various rates)
7. WMSC - ATCCC (Wash D.C.)	Service A Network (1200 bps) for transfer of weather observations and forecasts to ATCCC.	NADIN - Data transfer from WMSC to NADIN switch (4800 bps), then to ATCCC (4800 bps) (half duplex).	NC

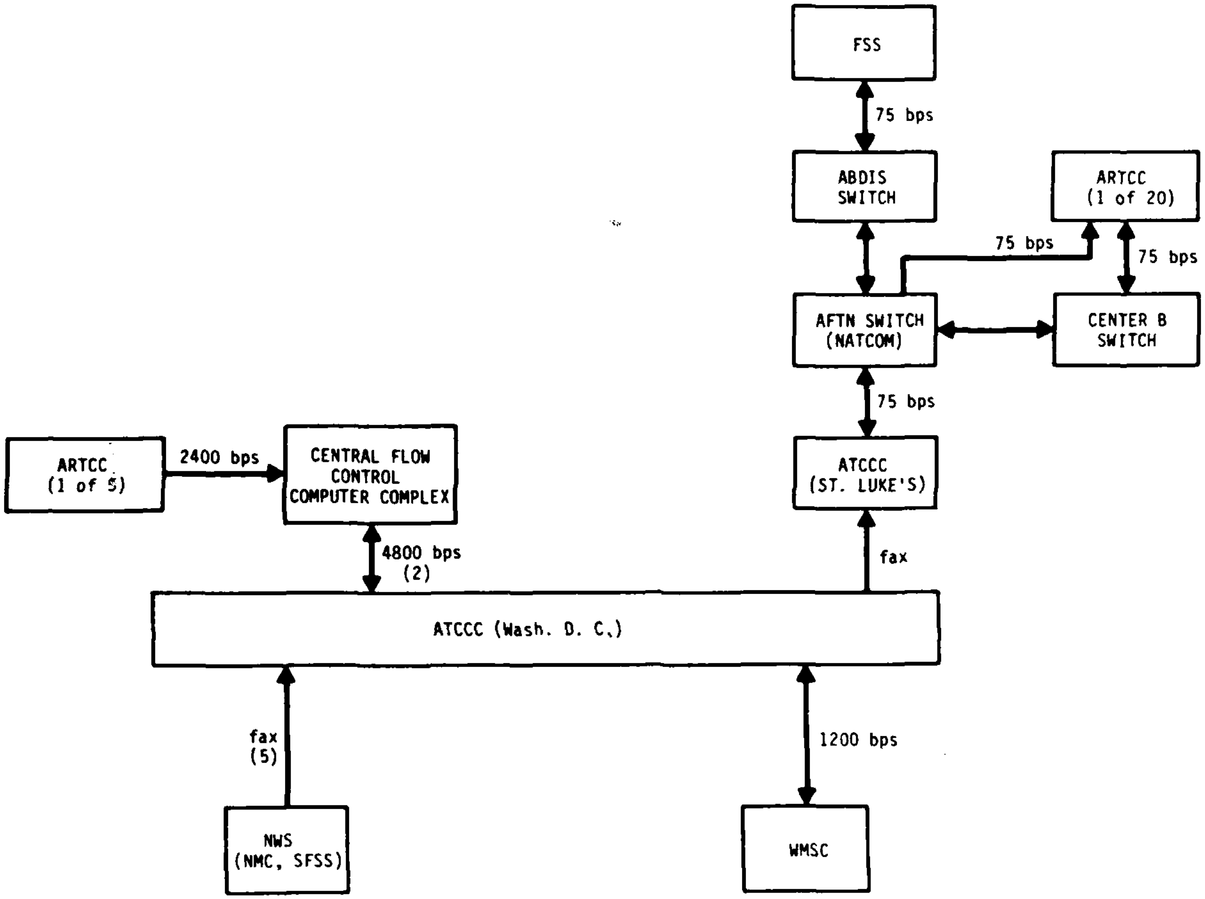
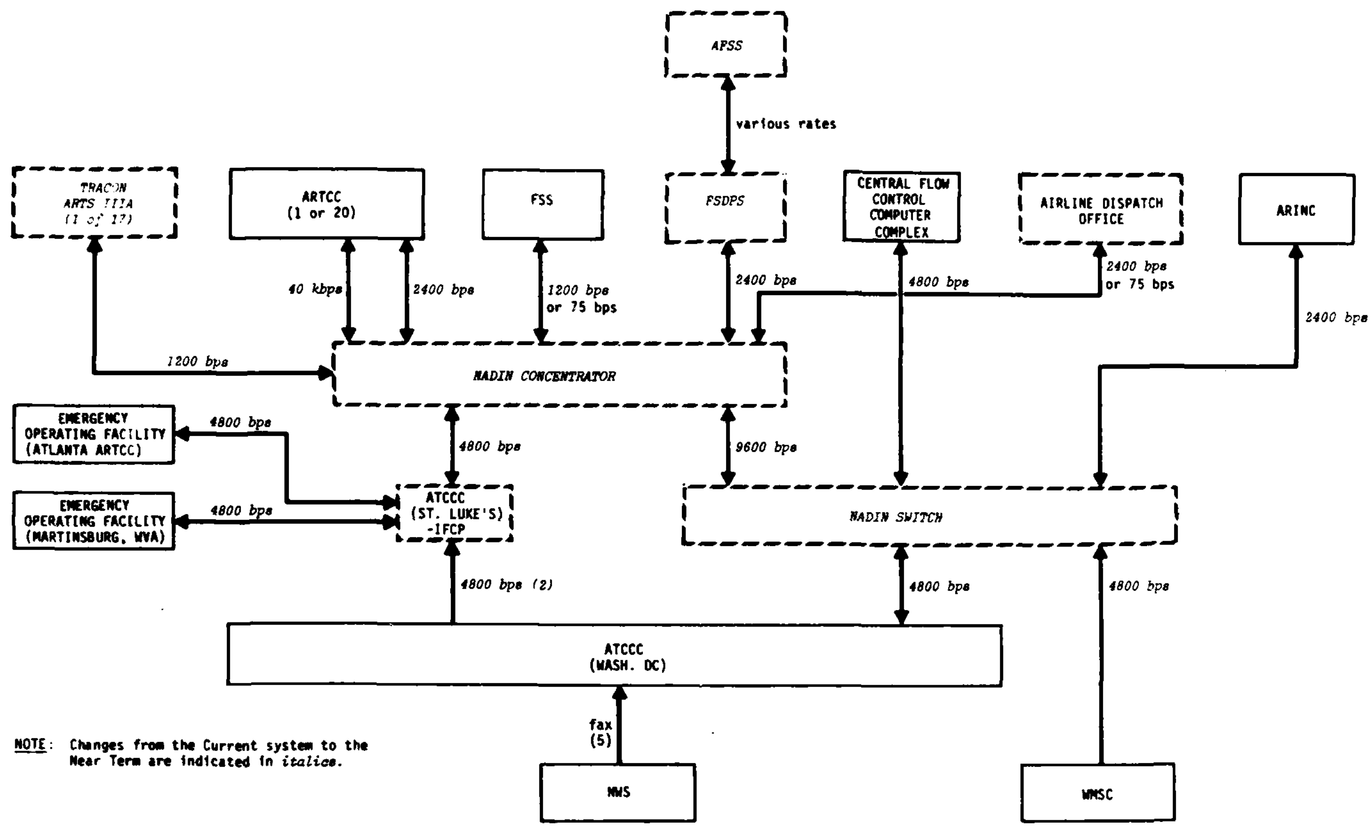


FIGURE 9-7
CURRENT ATCCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 9-8
NEAR TERM ATCCC DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

Weather data from NWS (WX radar, WX charts, satellite maps, WX forecasts and high winds forecasts) are transmitted over dedicated facsimile lines and a high speed teletypewriter circuit. Radar data from 37 weather radar sites can be accessed via 3 dial-up lines to facsimile equipment in the ATCCC (Washington D.C.)

Near Term ATCCC Facilities

The transmission of flight movement directives between the ATCCC (Washington D.C.) and ARTCCs by facsimile circuits and the Center B teletypewriter network in the current system is replaced by NADIN. The ATCCC (Washington D.C.) is connected directly to the ATCCC (St. Luke's) facility by two (2) dedicated 4800 bps lines. The ATCCC (St. Luke's) facility is connected to a NADIN concentrator, whereby access to all ARTCCs is obtained.

Flow control flight movement data from each ARTCC is sent to the CFCCC through NADIN. Transfer of flow control data from CFCCC to the ATCCC (Washington D.C.) is via the NADIN switch without going through concentrators. Flow control data will divide between the two NADIN switches.

Emergency Operating Facilities (EOF) in Atlanta, Ga. and Martinsburg, W. Va. will be established in the Near Term time period as backup facilities for the ATCCC (Washington D.C.) facility. Each of these EOFs will be connected to the ATCCC (St. Luke's) facility with dedicated 4800 bps lines for transfer of flight control directives to ARTCCs and FSSs via NADIN.

The weather radar, weather charts, and satellite maps will

continue to be sent from NWS to the ATCCC (Washington D.C.) as in the current system. However, weather observations and forecasts from WMSC will be transferred from the WMSC to the ATCCC (Washington D.C.) facility via NADIN.

Far Term ATCCC Facilities

ATCCC data transmission in the Far Term will be the same as in the Near Term.

9.1.1.4 Flight Service Facility Improvements

Flight Service Facilities data communications are primarily involved in the accumulation and organization of a weather data base, interactive communications with user terminals and the filing of flight plans and transmission of various administrative messages. Some basic assumptions used in describing the Flight Service data communications are listed in Table 9-7. Descriptions of the data communications facilities used for the three periods of interest, Current, Near Term and Far Term are provided in Table 9-8. Illustrations of the connectivity required in each time period are shown in Figures 9-9, 9-10 and 9-11, respectively. A discussion of each of these time periods is included in the following subparagraphs.

Current Flight Service Facilities

In the current Flight Service environment, pilots generally request weather and flight planning information over the counter at a FSS, or by telephone, or via a Service A terminal located at a remote site, e.g., airline office, fixed base operation,

TABLE 9-7

ASSUMPTIONS FOR FLIGHT SERVICE FACILITIES
DATA COMMUNICATIONS

1. Initial NADIN will replace the Area B, Center B, NASNET, AFTN and Utility B networks and provide data transmission capability for their subscribers. In addition, NADIN will interface with the WMSC, NWS network, ATCCC (Interim) and Service A (Req/Reply) Network for ARTCCs.

2. NADIN 1A provides data communications for the FDIO subsystem, the Service A (Req/Reply) Network for AFSSs, the AWP to FSDPS portion of the Model II FSS automation program, and the NFDC/IS (Interim), in addition to the requirements of Initial NADIN.

3. NADIN Enhancements -- In addition to the data communications requirements of Initial NADIN and NADIN 1A, NADIN Enhancements provide data communications for Computer B network, and interfaces with the NFDC/IS (Final), ATCCC (Final)/CFCCC, RMMS (MPS-MPS), Data Link, and other DOT data communications networks.

4. MAPS and AWANS will be phased out by the Model II FS Automation Program in the Near Term.

5. Model I FS Automation Program does not utilize NADIN.

6. The AWP will be consolidated with the WMSC functions in the Far Term.

TABLE 9-8
WEATHER AND FLIGHT SERVICE FACILITIES - DATA
COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
1. FS Facility - WMSC a. Weather data gathering	FSS to WMSC Service A Network - 75 bps multipoint circuits from all FSSs, and other FAA weather collection points.	AFSS to WMSC NC FSS and other FAA collection points to WMSC NC	AFSS to WMSC/AWP NADIN Enhancement - Data transfer from FSDPS to NADIN concentrators (2400 bps) to NADIN switch (9600 bps), then to WMSC/AWP (4800 bps). FSS - to WMSC/AWP NA Other FAA Collection Points (including JAWOS, etc.) to WMSC/AWP NC
b. Distribution of Weather Products	WMSC to FSSs Service A Network - 75 bps multipoint circuits to all FSSs WMSC to other weather users Service A Network - various rate circuits (up to 2400 bps) to weather users.	WMSC to AFSS NADIN 1A - Data transfer from WMSC to NADIN switch (4800 bps) to AWP (4800 bps), to NADIN switch (4800 bps), to NADIN concentrator (9600 bps), to FSDPS (2400 bps), and then to AFSS (9600 bps) in response to requests. WMSC to FSSs and other users NC	WMSC/AWP to AFSS - NADIN Enhancement - Data transfer from WMSC/AWP to NADIN concentrator (4800 bps), to FSDPS (2400 bps), and then to AFSS (9600 bps) in response to requests. WMSC/AWP to FSSs NA WMSC/AWP to other weather users. Data transfer from WMSC/AWP to NADIN switch (4800 bps), to NADIN concentrator (9600 bps), then to AFSSs and other weather users (various rates).

TABLE 9-8
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
2. WMSC - ARTCC Weather Products	Service A Network Request/Reply service (75 bps) to provide requested weather data to ARTCC (half duplex).	NADIN - Request from ARTCC to NADIN concentrator (2400 bps), to NADIN switch (9600 bps) then to WMSC (4800 hps). Reply follows reverse path.	NADIN Enhancement - Requests from ARTCC to NADIN concentrator (2400 bps), to NADIN switch (9600 bps) then to WMSC/AWP (4800 bps). Reply follows reverse path.
3. WMSC - National Weather Service Exchange of weather data (alphanumeric data only).	WMSC to/from NMC Service A Network - (2) 2400 bps circuits from WMSC to National Meteorological Center WMSC to/from WSFOs Service A Network - 75 bps multipoint circuits from WMSC to all Weather Service *Forecast Offices.*	WMSC to NMC NADIN - Data transfer from WMSC to NADIN switch (4800 bps) then to NMC (2400 bps) and vice versa WSFOs to NMC Service A Network replaced with AFOS Network. WSFOs transmit weather data to *NMC via AFOS Network.*	WMSC/AWP to NMC NADIN Enhancement - Data transfer from WMSC/AWP to NADIN switch (4800 bps) then to NMC (2400 bps) and vice versa. WSFOs to NMC NC

TABLE 9-8
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
4. ADWS - WMSC	Military weather data transfer from Air Force Digital Weather Service (ADWS) at Carswell Air Force Base to WMSC via dedicated line (1200 bps).	NC	Data transfer same as Current time frame except ADWS is connected to consolidated WMSC/AWP.
5. NMC - FS Facility Weather Maps	NMC TO FSS Leased facsimile circuits to distribute weather maps.	NMC to FSS Leased facsimile circuits to distribute weather maps. NMC to AFSS (Model I) Leased facsimile circuits to distribute weather maps. NMC to AFSS (Model II) Dedicated facsimile circuits deleted. NMC transmits digital weather maps to AWP (2400 bps), to NADIN switch (4800 bps), to NADIN concentrator (9600 bps) to FSDPS (4800 bps) where weather maps are stored in FSDPS data base for later transmission to AFSS.	NMC to FSS NA NMC to AFSS (Model I) NA NMC to AFSS (Model II) NC

AD-A103 241 MITRE CORP MCLEAN VA F/G 1/2
FUTURE ATC SYSTEM DESCRIPTION ATC FACILITIES AND INTERFACES (19--ETC(U)
JAN 81 J H CHILDERS, R C HUNTER, D TUTTLE DOT-FA01-81-C-10001
UNCLASSIFIED MTR-81W6 FAA/RD-81/17 NL

5 OF 5
AD
A103241

END
DATE
FILMED
10-81
DTIC

TABLE 9-8
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
6. NWS/NMC - AWP Weather maps (graphic data to AWP)	NA	Leased line - 2400 bps circuit from NMC to AWP	NC
7. SFSS - FS Facility	NOAA satellite pictures transmitted to FSSs via dedicated facsimile circuits.	NOAA satellite pictures transmitted from SFSS to FSSs and AFSSs via dedicated facsimile circuits.	NOAA satellite pictures transmitted to WMSC/AWP, to NADIN switch (4800 bps), to NADIN concentrator (9600 bps), to FSDPS (4800 bps) for later transmission to AFSSs.
8. Weather Radar - FSS	Digitized 2D Weather Data from NWS Weather Radar or En Route Surveillance Site to FSS.	NC	NA
9. Weather Radar - AFSS	NA	Digitized 2D Weather Radar from CD at a surveillance site (dedicated or dial-up) to FSDPS (2400 bps) to AFSS (4800 bps).	Weather data transfer via one dedicated 2400 bps channel from NEXRAD. Weather radar site to FSDPS (2400 bps) to AFSS (4800 bps)

TABLE 9-8
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
10. FSDPS - DUATS Interactive access to weather data base for weather briefings and filing of flight plans.	NA	Dedicated lines - 2400, 4800 and 9600 bps channels to allow users to access the FSDPS. Up to 3 user terminals will share each line. Dial-in-ports (300 and 1200 bps) allow some users to access the FSDPS. Only one user terminal can use a dial-in line at a time.	NC
11. FS Facility - ARTCC Entry of IFR flight plans, etc.	AFSS to ARTCC NA FSS to ARTCC Area B Network - Message transfer from FSS to ABDIS switch (75 bps multipoint) then to ARTCC manual position (75 bps) for formatting and processor entry.	AFSS to ARTCC (NADIN 1A) Message transfer from AFSS to FSDPS (9600 bps) to NADIN concentrator (4800 bps), to NADIN switch (9600 bps), to NADIN concentrator (9600 bps) then to 9020 Processor (up to 40 kbps) FSS to ARTCC NADIN 1A-Message transfer from FSS to NADIN concentrator (75 bps) to NADIN switch (9600 bps) to NADIN concentrator (9600 bps) then to ARTCC manual position (2400 bps) for formatting and entry into the 9020 Processor.	AFSS to ARTCC NC FSS to ARTCC NA

TABLE 9-8
(CONTINUED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
12. FS Facility - Other ARTCCs, other FSDPSs, Mil Base Ops, CFCCC, ATCCC, Records Center, NATCOM, Aeronautical Center, FAA Technical Center, etc.			
Miscellaneous Communications to file or update VFR flight plans, to access remote data bases, and for other miscellaneous messages.	AFSS to destination NA	AFSS to destination (NADIN 1A) Message transfer from AFSS to FSDPS (9600 bps) to NADIN concentrator (4800 bps), to NADIN switch (9600 bps), then to destination (via a destination compatible circuit) and vice versa.	AFSS to destination NC
	FSS to destination - Message transfer from FSS to ABDIS switch (75 bps multipoint) then to destination (on a destination compatible circuit) and vice versa.	FSS to destination - NADIN 1A-Message transfer from FSS to NADIN concentrator (75 bps multipoint) to NADIN switch (9600 bps), then to concentrator (9600 bps), then to destination (via a destination compatible circuit) and vice versa. (ATCCC and CFCCC are terminated in NADIN switch)	FSS to destination NA

TABLE 9-8
(CONCLUDED)

FUNCTION	CURRENT (1980)	NEAR TERM (1981-84)	FAR TERM (POST-1984)
13. NFDC - WMSC	Message transfer from NFDC terminals to WMSC data base (at NATCOM) and vice versa via dedicated leased lines for NOTAM information.	Message transfer from NFDC terminals to NADIN concentrator, to NADIN switch (9600 bps), to Interim Consolidated NOTAM system (CNS) for NOTAMs and Airmen's Information collection and distribution and vice versa.	Message transfer from NFDC terminals to NADIN concentrator to NADIN switch (9600 bps) to Permanent CNS at NADIN switch location in Atlanta for NOTAM and Airmen's Information collection and distribution.
14. NFDC - Int'l. AFTN	Message transfer from NFDC to Int'l. AFTN via dedicated leased lines (1200 bps) and vice versa for international NOTAM information.	Message transfer from NFDC terminals to NADIN concentrator, to NADIN switch (9600 bps), to Int'l AFTN switch for international NOTAM information.	NC
15. VORTAC/NDB - FS Facility	VORTAC/NDB Status Information transmitted to FSSs via dedicated lines.	VORTAC/NDB Status Information transmitted to FSSs and AFSSs via dedicated lines.	NC

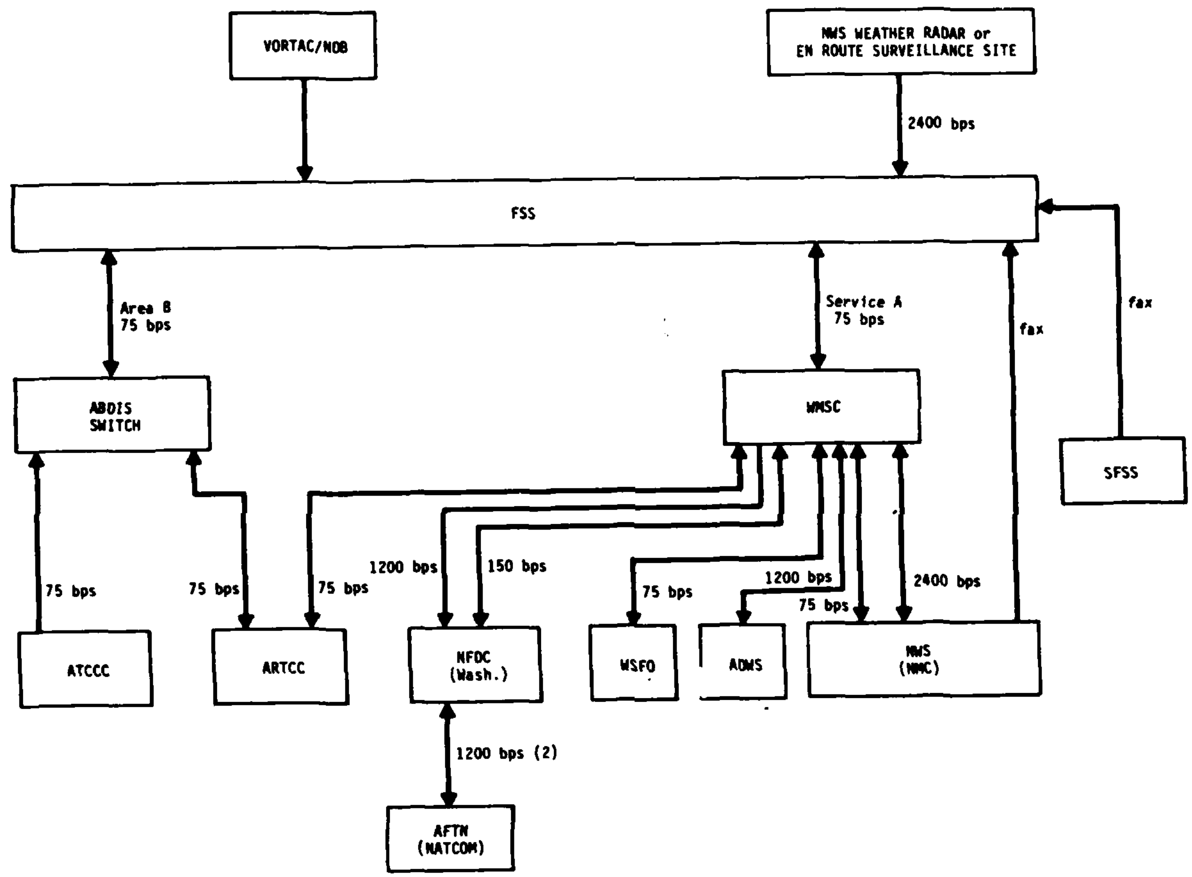
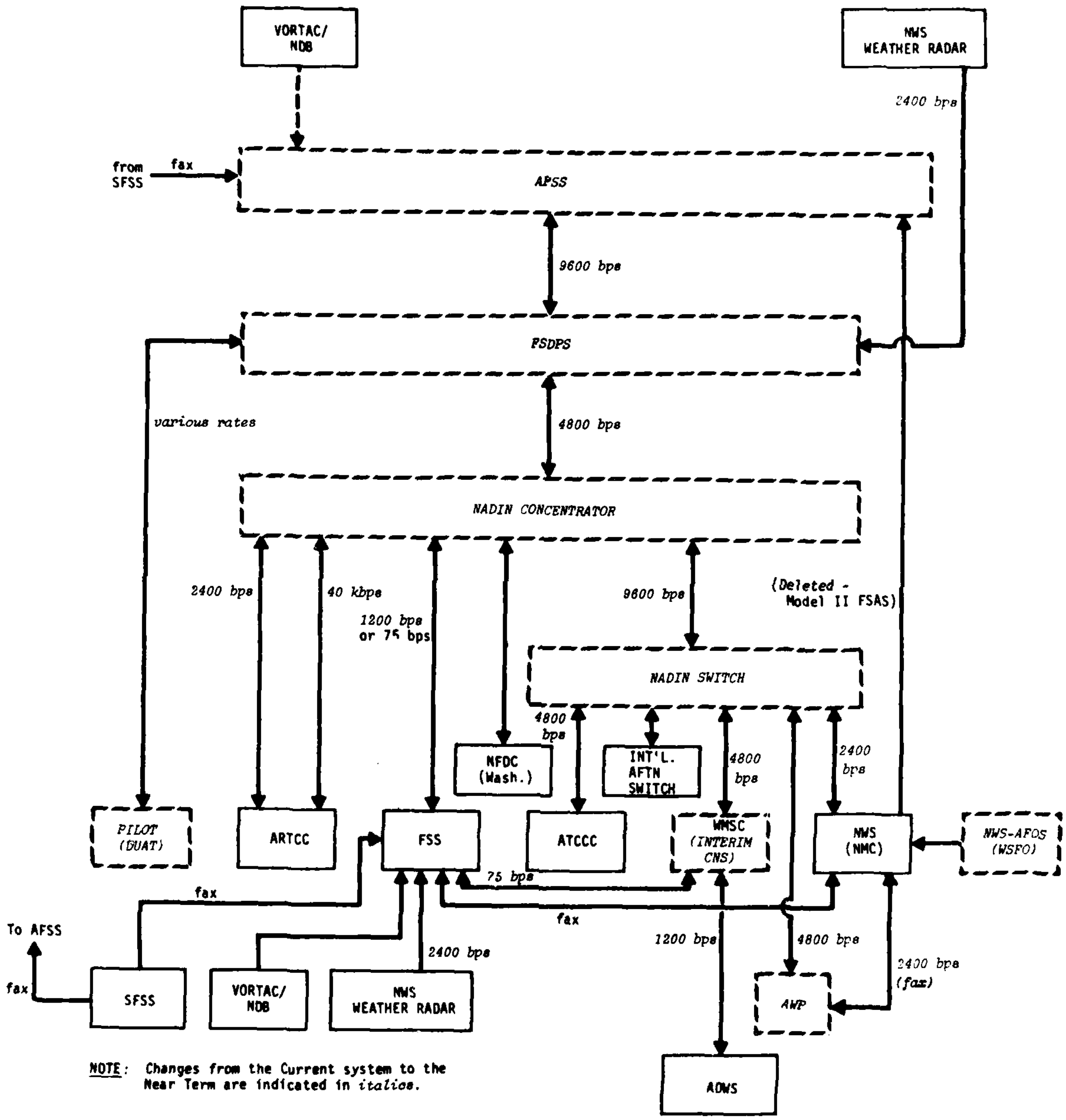
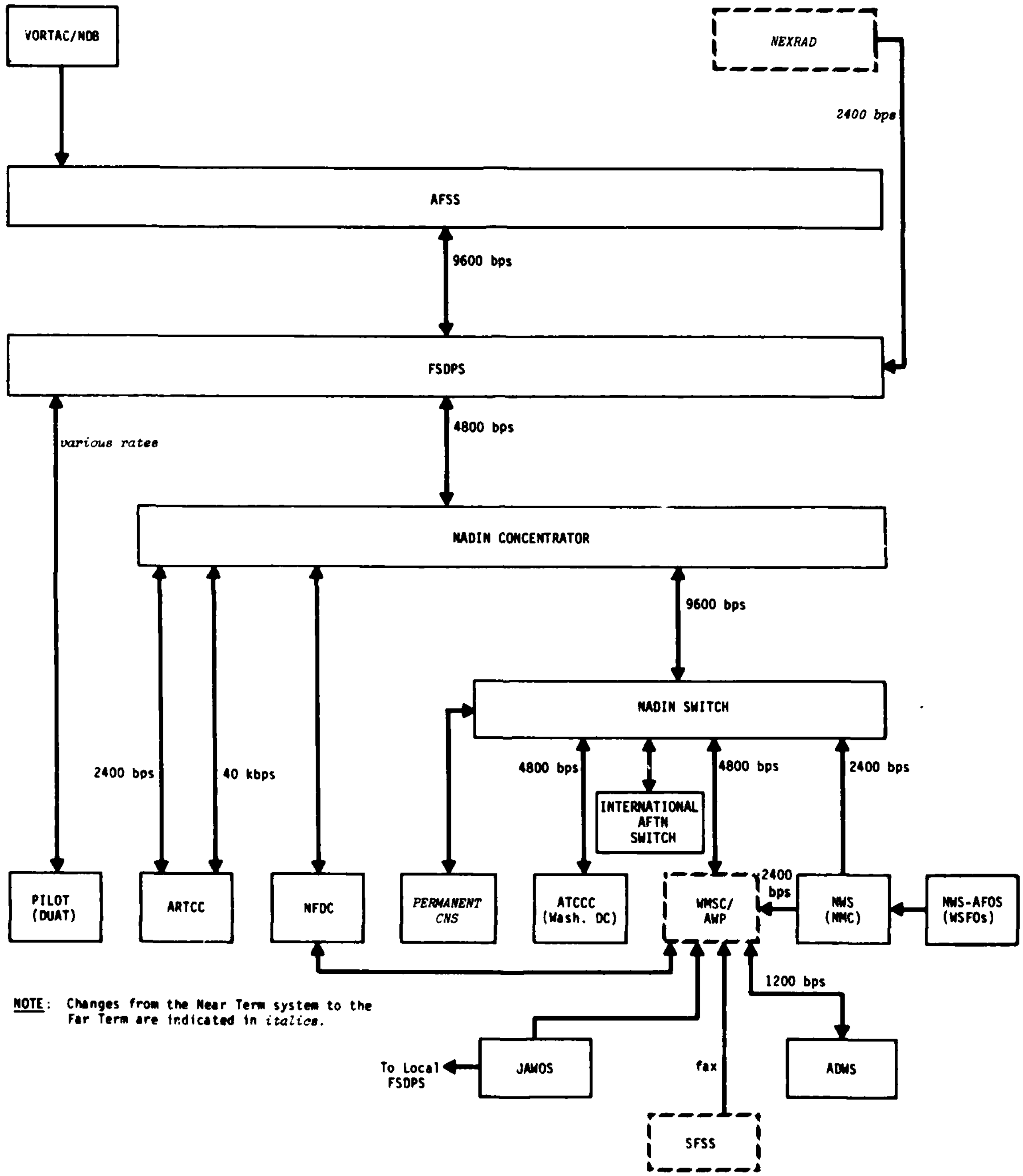


FIGURE 9-9
CURRENT FLIGHT SERVICE DATA COMMUNICATIONS
CONNECTIVITY DIAGRAM



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 9-10
NEAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 9-11
FAR TERM FLIGHT SERVICE DATA COMMUNICATIONS CONNECTIVITY DIAGRAM

etc. Once flight plans are prepared, they are filed into the ARTCC (IFR flights) or to the destination FSS (VFR flights) through the Area B network.

In the Current systems, Figure 9-9, the Weather Message Switching Center (WMSC) collects weather data from FSSs, from the National Weather Service - National Meteorological Center, (NMC), from Weather Service Forecast Offices (WSFO), from the Air Force Digital Weather System (ADWS), and from other collection points. These data are organized by the WMSC and transmitted to all FSSs over the Service A teletypewriter network. These data are maintained in the FSSs on clipboards and are referred to in pilot briefings by the FSS specialist.

Digitized 2D weather data from NWS weather radars and en route surveillance sites are transmitted to some FSSs over dedicated 2400 bps lines. Military weather data will be transferred from the Air Force Digital Weather Service (Carswell AFB) to the WMSC via dedicated 1200 bps lines.

Weather maps from NWS (NMC) are obtained at FSSs via dedicated facsimile circuits tailored to the needs of their specialized function. NOAA satellite pictures are also transmitted to the FSSs via facsimile circuits.

VORTAC/NDB status information is transmitted to FSSs over dedicated lines in the Current time period.

Access to the NOTAM data base at NATCOM in Kansas City is via dedicated 1200 bps leased lines from NFDC (Washington D.C.) terminals. The NOTAM data base is stored on two computer

systems. Domestic NOTAMs are stored in the WMSC computer system and international NOTAMs are stored in the AFTN computer system. Domestic NOTAMs are issued by FSSs and are transmitted to the WMSC data base via the Service A network. The NFDC (Washington D.C.) also issues domestic NOTAMs concerning unpublished regulatory information. These are transmitted to the WMSC data base via dedicated leased lines.

International NOTAMs will be received over the AFTN network from foreign nations at the AFTN data base in Kansas City. U.S. International NOTAMs will be transmitted by the NFDC to the AFTN data base via dedicated leased lines.

Near Term Flight Service Facilities

The Near Term will see the initiation of the Flight Service Automation System (FSAS) program (References 9-8, 9-9, and 9-10), Figure 9-10. In this period, the Model I FSS functions will be automated with the introduction of 14 Flight Service Data Processing Systems (FSDPS), located at selected ARTCCs, and 41 Automatic Flight Service Stations (AFSS) located at existing level III facilities while the manual FSSs will continue to operate at the remaining locations.

Later in the Near Term, Model II FSAS will be introduced. Six (6) additional FSDPSs will be installed at the remaining ARTCC locations. The number of AFSSs will be increased to 56 with 43 of these being located at existing FSS locations. Two Aviation Weather Processors (AWP) will be installed to provide centralized weather data base maintenance.

Interactive access to weather data base for weather briefings and filing of flight plans will be provided to the FSDPS via dedicated lines from Direct User Access Terminals (DUAT). During this time period, NADIN will take over the transmission functions of the Service A and Area B Networks in accumulating weather data and filing flight plans.

Weather radar data will continue to be transmitted from NWS weather radar or en route surveillance sites to FSSs as in the Current time period. However, weather radar data to AFSSs will be transmitted over dedicated 2400 bps lines via the FSDPS in the Near Term.

Weather maps from NWS (NMC) will continue to be obtained via dedicated facsimile circuits at FSSs and AFSSs. During the Model II phase of the FSAS program these dedicated facsimile circuits to the AFSSs will be replaced. The NMC will then transmit digital weather map data directly to the AWP, then it will be forwarded to the FSDPS via NADIN to be stored in its data base for later use by the AFSSs.

NOTAMs and Airmen's Information will be transmitted between NFDC (Washington D. C.) terminals and the newly established Interim Consolidated NOTAM System (CNS) via NADIN 1A.

In the Near Term time period, the WMSC to NWS (NMC) weather data transfer via the Service A network will be replaced by NADIN. The Service A Multi-point circuits which interconnect the WSFOs to the WMSC will be replaced by the AFOS network in the Near Term. The WSFOs will transmit local weather data to the NMC over this AFOS network. The NMC will then transmit this data to

the WMSC via NADIN.

International NOTAM information will be transmitted between NFDC and the International AFTN switch via NADIN in the Near Term replacing the dedicated lines used in the Current time period.

NOAA satellite pictures will continue to be trasmitted via dedicated facsimile circuits from SFSS to both FSSs and AFSSs.

Far Term Flight Service Facilities

In the Far Term the weather data base functions of the WMSC and Aviation Weather Processor (AWP) will be consolidated into the AWP facility. Three additional FSDPSs will be installed at San Juan, Honolulu and Anchorage along with 5 additional AFSSs. Weather observations will continue to be made by other FAA personnel (e.g. tower personnel), contracted personnel, NWS personnel or automated equipment at FSS facilities. Data communications for these system elements will be provided by NADIN.

Pilot access to the FSDPS in the Far Term will be through the use of dial-up access terminals as in the Near Term.

In the Far Term, a permanent CNS will be set up at the NADIN switch location in Atlanta for NOTAM and Airmen's Information collection and distribution. Message transfer between NFDC terminals and the permanent CNS will be via NADIN.

NOAA satellite pictures will be transmitted over dedicated lines to the WMSC/AWP and then via NADIN to the FSDPS for later

distribution to the associated AFSSs. Due to the high data rate required for digital facsimile, this may result in a technical problem for NADIN.

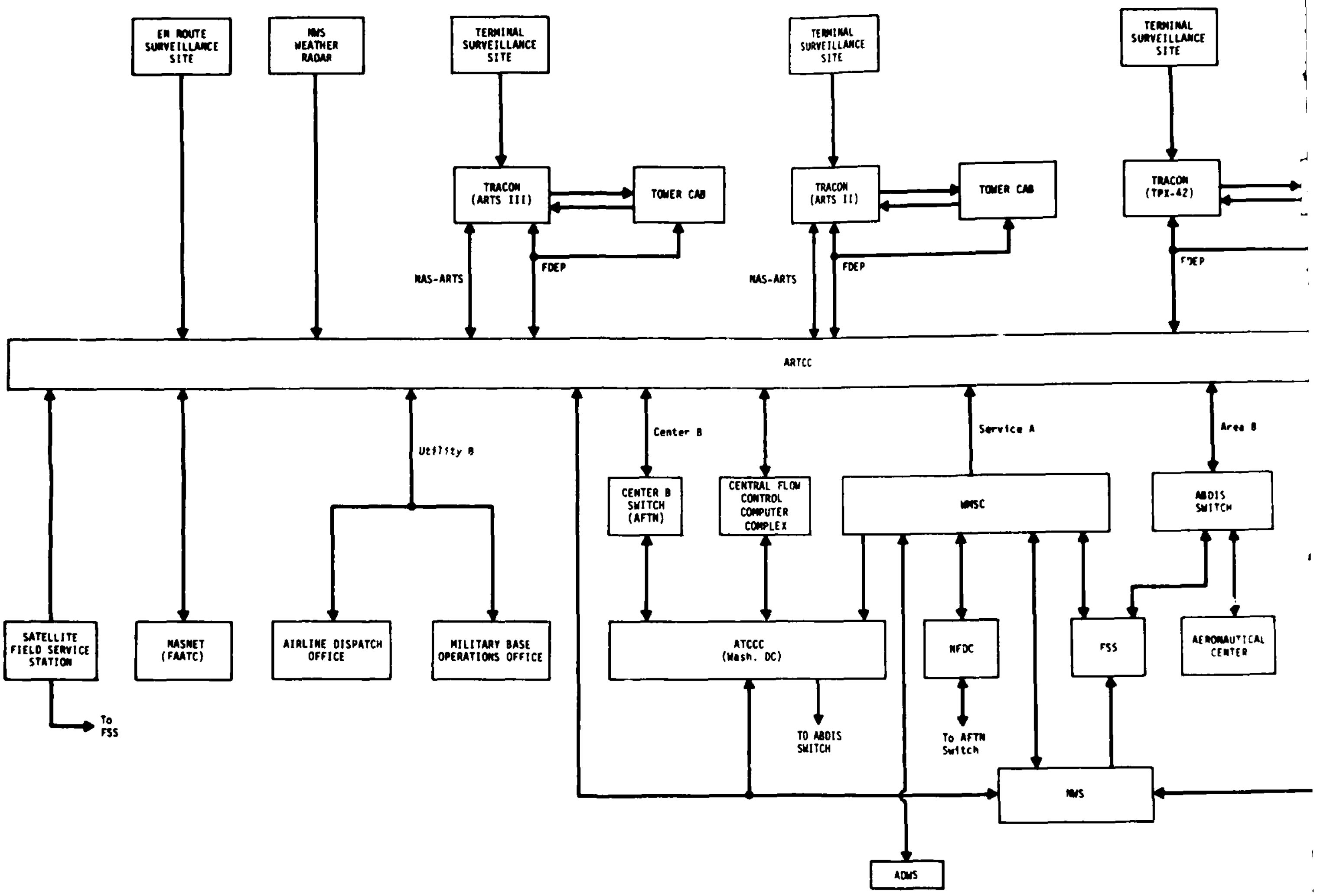
NOTAMs and Airmen's Information will be transmitted from the NFDC (Washington D.C.) terminals to the Permanent Consolidated NOTAM System in Atlanta via NADIN for both NOTAM and Airmen's Information collection and distribution in the Far Term.

9.1.2 Data Communications Networks

The current FAA data communications capability is characterized by the use of a number of separate independent networks. Efforts are currently underway to combine these separate capabilities into a single network, the National Airspace Data Interchange Network (NADIN), which will meet the varied needs of present FAA operations and provide capacity for growth to accommodate future requirements as they develop. This section will describe the current networks, the NADIN concept and how NADIN will meet the FAA needs for data communications.

9.1.2.1 Current Data Communications Network

Current FAA data communications are illustrated in Figure 9-12. Each network (Area B, Center B, NASNET, Service A, AFTN, etc.) is shown together with the primary facilities served and the element which controls it. Although most of the networks are teletypewriter networks, there is, in general, no automatic interconnection between them. The principal characteristics of these networks are listed below.


EN ROUTE SURVEILLANCE SITE
NWS WEATHER RADAR
TERMINAL SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TRACON (ARTS III)
TOWER CAB
TRACON (ARTS II)
TOWER CAB
TRACON (TPX-42)
NAS-ARTS
FDEP
NAS-ARTS
FDEP
FDEP
ARTCC
Utility B
Center B
Service A
Area B
CENTER B SWITCH (AFTN)
CENTRAL FLOW CONTROL COMPUTER COMPLEX
WMSC
ABDIS SWITCH
SATELLITE FIELD SERVICE STATION
NASNET (FAATC)
AIRLINE DISPATCH OFFICE
MILITARY BASE OPERATIONS OFFICE
ATCCC (Wash. DC)
NFDC
FSS
AERONAUTICAL CENTER
To FSS
TO ABDIS SWITCH
To AFTN Switch
NWS
ADWS

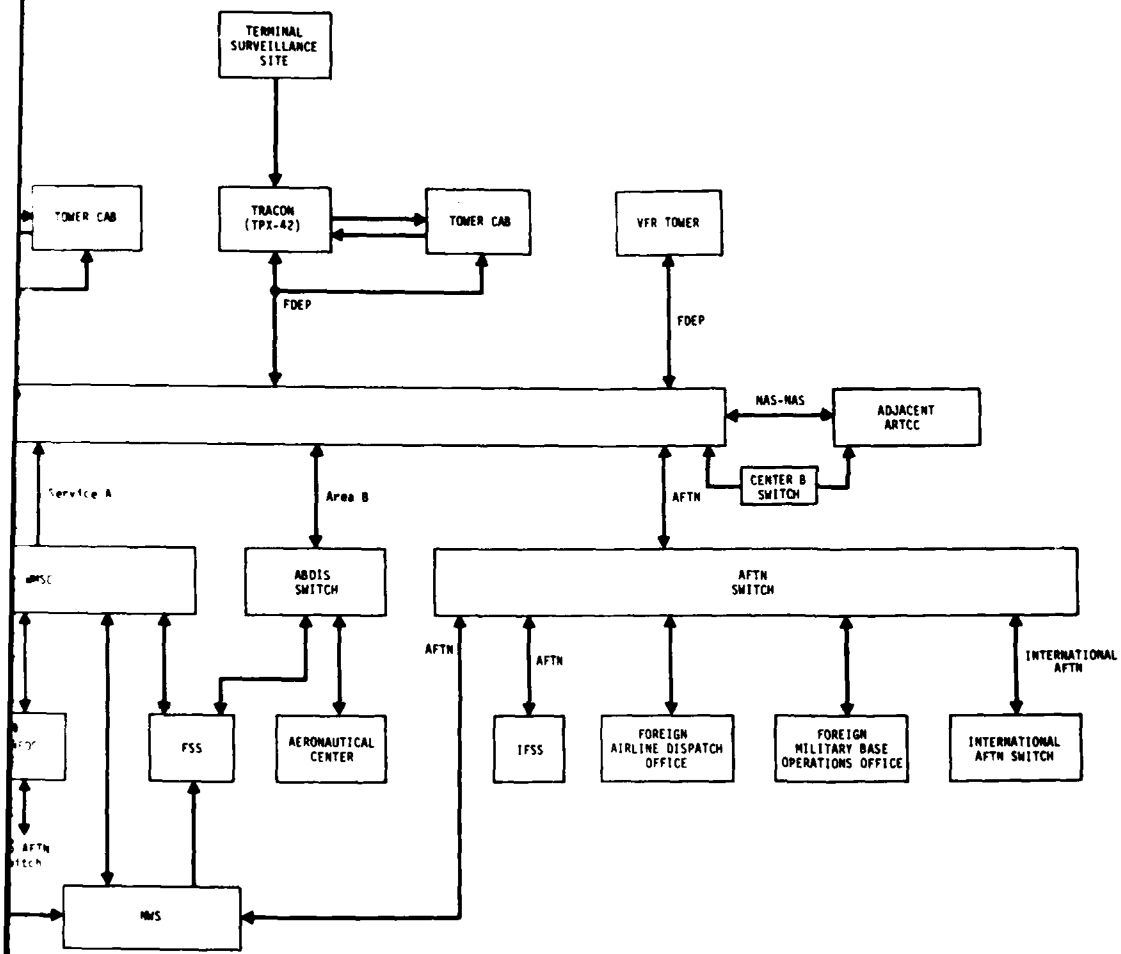


FIGURE 9-12
CURRENT DATA COMMUNICATIONS

PRECEDING PAGE BLANK-NOT FILMED

Area B and Supplemental B Circuits

The Area B network is generally used for exchanging flight planning information and various types of administrative messages. The network consists of five (5) medium speed circuits to other computers (e.g. AFTN, MAPS, AWANS) and 50 multipoint circuits terminating over 300 terminals located at FSSs, ARTCCs and other FAA facilities. All terminals are Model 28 series teletypewriters or compatible equipments. Control of each circuit as well as exchange of traffic between circuits is performed by the Automated Service B Data Interchange System (ABDIS) located at Kansas City, Missouri.

Supplemental B circuits are provided to relieve the high traffic load at certain high density Area B terminations. In general, the terminal equipments are Model 28 send/receive teletypewriters.

Center B

The Center B network interconnects the 20 ARTCCs within the conterminous U.S., and is used for the interchange of flight movement information. The network consists of nine circuits interconnecting the ARTCCs. All terminals are Model 28 teletypewriter equipment. Control of the circuits and interchange of traffic between them is handled by the AFTN switch at NATCOM in Kansas City, Missouri.

NASNET

Another teletypewriter network is the NASNET which interconnects

the automated ARTCCs, selected ARTS III sites, all regional offices and FAA Headquarters with the FAA Technical Center. This network is used for the exchange of information pertinent to the operations of the en route automation computers. The network consists of two multipoint circuits and a controller located at NATCOM in Kansas City, Missouri.

Service A

The Service A network interconnects teletypewriters and some medium speed (1200 or 2400 bps) terminals at facilities which collect or use weather data. The network is specialized in that it handles primarily weather data. Weather observations and related messages are prepared at FSSs on punched paper tape and are inserted in the teletypewriter's tape reader. The Weather Message Switching Center (WMSC) polls these stations and collects their reports. The WMSC then organizes this weather data and distributes it to user locations. Some users, such as the ARTCCs, have Request/Reply (R/R) service which allows them to obtain specific weather information on request.

AFTN

The Aeronautical Fixed Telecommunications Network (AFTN) provides for the exchange of international flight movement information, administrative messages, and meteorological data between locations in the U.S. and in the International Civil Aviation Organization (ICAO) member nations. The terminals are Model 28 teletypewriter equipment, but they use a code which is slightly different than that used commonly in the United States.

While the AFTN is international, the United States operates a switching center at Kansas City (NATCOM). The AFTN switch at NATCOM is a major one providing the interconnection between some 110 circuits to points in the conterminous U.S., San Juan, Honolulu, Anchorage, Balboa and other foreign countries.

Utility B

Utility B circuits are a combination of the circuits previously known as Military B and Carrier B. They are used for filing flight plans for general coordination between the centers and the principal users. The terminals are Model 28 teletypewriter equipment. Control of the Utility B circuits is done by the Automatic Polling Unit Low Speed (APULS) equipment.

FDEP

FDEP circuits terminated at each center provide for the entry of flight plans and the distribution of flight strips to TRACONs and Towers within the center's area of coverage. The terminals operate in a mode and at a rate similar to teletypewriters, however, the code is the EBCDIC code used in the en route automation processors. Control of these circuits is provided by the en route automation processors.

NAS to NAS

Medium speed circuits are used between adjacent ARTCCs and between ARTCCs and TRACONs for the exchange of data between computers. These circuits operate at 2400 bits per second, full duplex, and utilize the EBCDIC code of the en route automation

computers.

Radar

Beacon and surveillance data are transmitted from the remote radar sites to the ARTCC NAS 9020 computers via 2400 bps data channels. Beacon and surveillance radar display data are transmitted to the TRACONs and Tower "BRITE" displays on video bandwidth channels via Radar Microwave Links (RML), or coaxial cables.

9.1.2.2 National Airspace Data Interchange Network (NADIN)

The National Airspace Data Interchange Network (NADIN) will provide data communications service to all users. Thus, it will provide the capability for message exchange between users who are presently terminated on separate networks. Users such as the FSSs and the ARTCCs, which presently have several terminals because they require access to several different networks, will be able to consolidate their operations, assigning terminals for operator convenience rather than network compatibility. The NADIN will provide code, speed, and format conversion necessary to make the unlike terminal equipments compatible. Introduction of the NADIN will provide the following improvements for the data communications users:

1. Unlike the present system which consists of a number of independent networks, NADIN will allow any user to communicate with any other user.

2. The number of terminals at some locations may be reduced.

3. By providing automatic codes, speed and format conversion, traffic may be exchanged among existing terminals which are now incompatible.

4. The number of terminals on a multipoint circuit will be reduced, thereby reducing the waiting time to use the circuit.

5. By concentration, the long haul circuits will be used much more efficiently, thereby reducing the system operating costs.

6. Use of error detection and correction techniques on trunks will eliminate most transmission errors.

7. The system will maintain a record of all traffic handled. This may be used to trace messages, to analyze traffic load patterns, and provide a basis for identifying requirements for future growth.

8. The system will maintain a copy of all accountable message traffic in classes that might be required for future retrieval.

9. The system will provide the means for substituting faster or more sophisticated terminals as the need for such terminals develops.

10. NADIN will monitor each terminal, will detect failures in some terminals and alert user to failure, where possible.

NADIN Network

NADIN will operate in a network as illustrated in Figure 9-13. The network will include two message switching centers: one located at Atlanta, Georgia, the other at Salt Lake City, Utah, and 23 concentrators, one located with each ARTCC, including Anchorage, Honolulu and San Juan. The message switches will accept messages from originating stations, store them and transmit them to destination stations in sequence by age and priority. The concentrators will provide code and speed compatibility required for the variety of terminal devices and will concentrate all user traffic to efficiently use trunk facilities to the message switch. The functional relationship between the concentrators and message switches is shown in Figure 9-14.

NADIN Program Plan

The NADIN implementation has been divided into three phases, referred to as NADIN, NADIN 1A, and NADIN Enhancements. In each level certain classes of traffic will be transferred into the NADIN network. In general, these categories of traffic, and the terminals of origination and termination are identified by the network which presently handles them. Where new categories of traffic are to be absorbed by NADIN, they are identified by indicating the destinations served. The NADIN levels and the categories of traffic for each are indicated in Table 9-9.

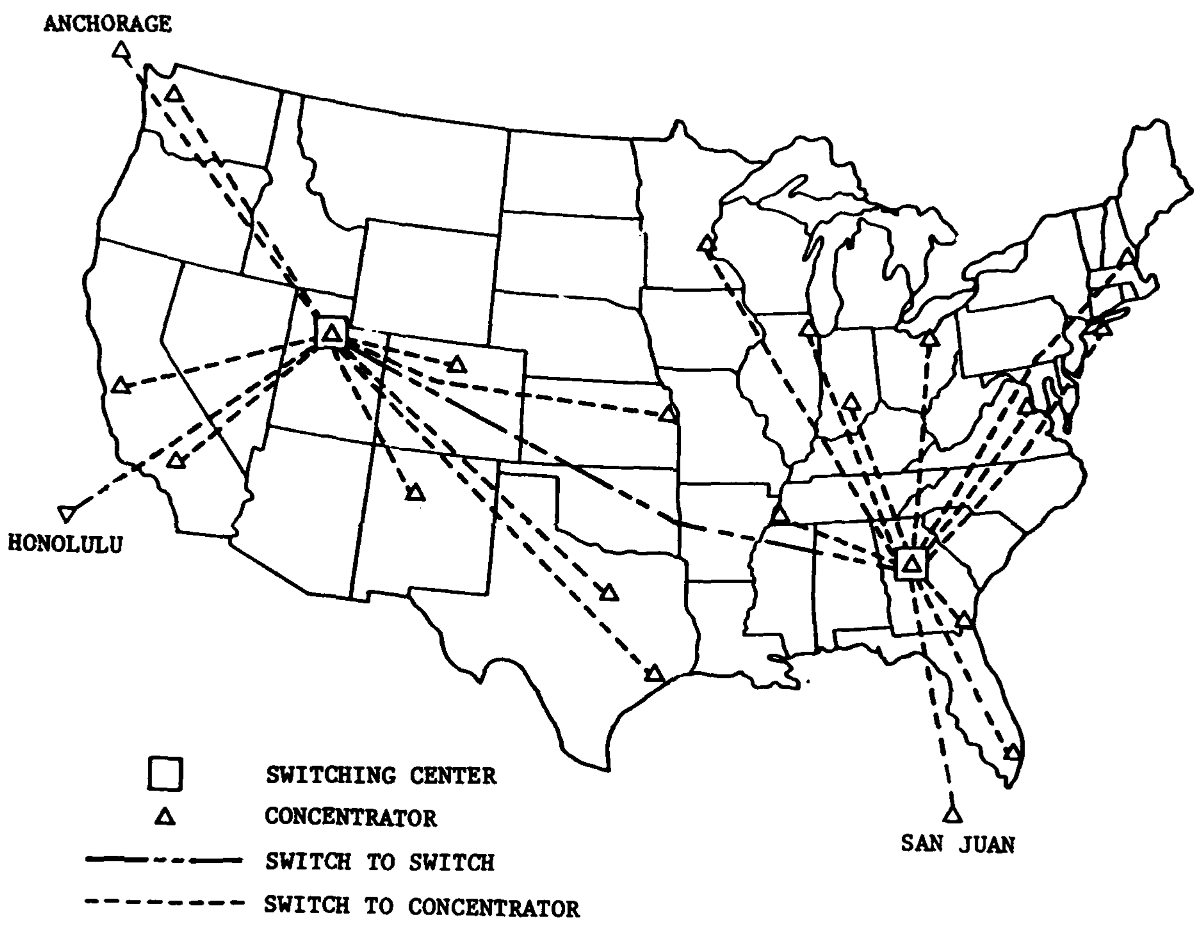


FIGURE 9-13
INITIAL NADIN CONFIGURATIONS

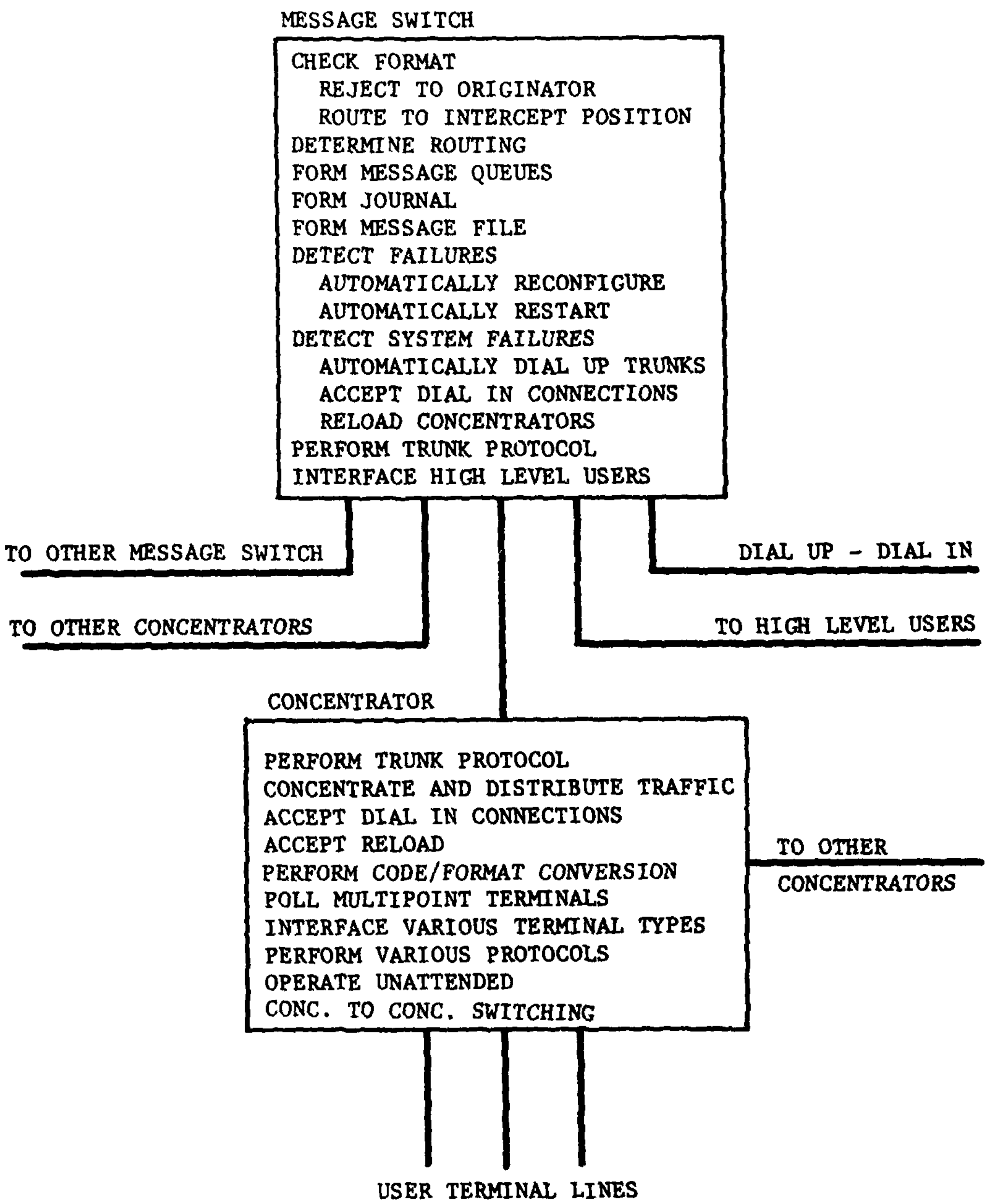


FIGURE 9-14
NADIN SUBSYSTEM FUNCTIONS

TABLE 9-9

TRAFFIC HANDLED BY NADIN

TRAFFIC CATEGORY	INITIAL NADIN	NADIN 1A	NADIN ENHANCEMENTS
Area B*	X		
Center B*	X		
NASNET*	X		
AFTN*	X		
Utility B*	X		
Service A Req/Reply (ARTCC)	X		
WMSC Interface*	X		
NWS Interface*	X		
ATCCC (Interim)*	X		
Canadian AFTN*	X		
ARINC Data Network Interface*	X		
NFDC/IS (Interim)*		X	
FS Automation System (Model II)*		X	
FDIO*		X	
Service A Req/Reply (AFSS)		X	
NFDC/IS (Final)*			X
Advanced Flow Control (ATCCC (Final)/CFCCC)			X
Computer B Center to Center			X
Computer B Center to Terminal			X
Modernized Weather Service (Req/Reply)			X
RMMS (MPS to MPS)			X
9020 Replacement			X
DABS/Data Link			X
DOT Data Comm. Networks			X

*Approved for Implementation by FAA

The basic switching capabilities of NADIN are improved and expanded in each phase of the NADIN program. These basic switching capabilities are outlined below:

Initial NADIN	a.	Concentrator to concentrator switching via the NADIN switch.
	b.	Concentrator to NADIN switch transmission rate - 4800 bps.
NADIN 1A	a.	Concentrator to concentrator switching via the NADIN switch.
	b.	Internal switching within concentrator provided, if NADIN is not accountable for journaling, e.g., FDIO system.
	c.	Concentrator to NADIN switch transmission rate increased to 9600 bps.
NADIN Enhancements		
	a.	Same as NADIN 1A capability
	b.	Additional concentrator to concentrator switching provided - method of implementation is not defined.

Both NADIN and NADIN 1A will be implemented during the Near Term period. NADIN Enhancements will be initiated during the Near Term, but will be implemented throughout the Far Term time

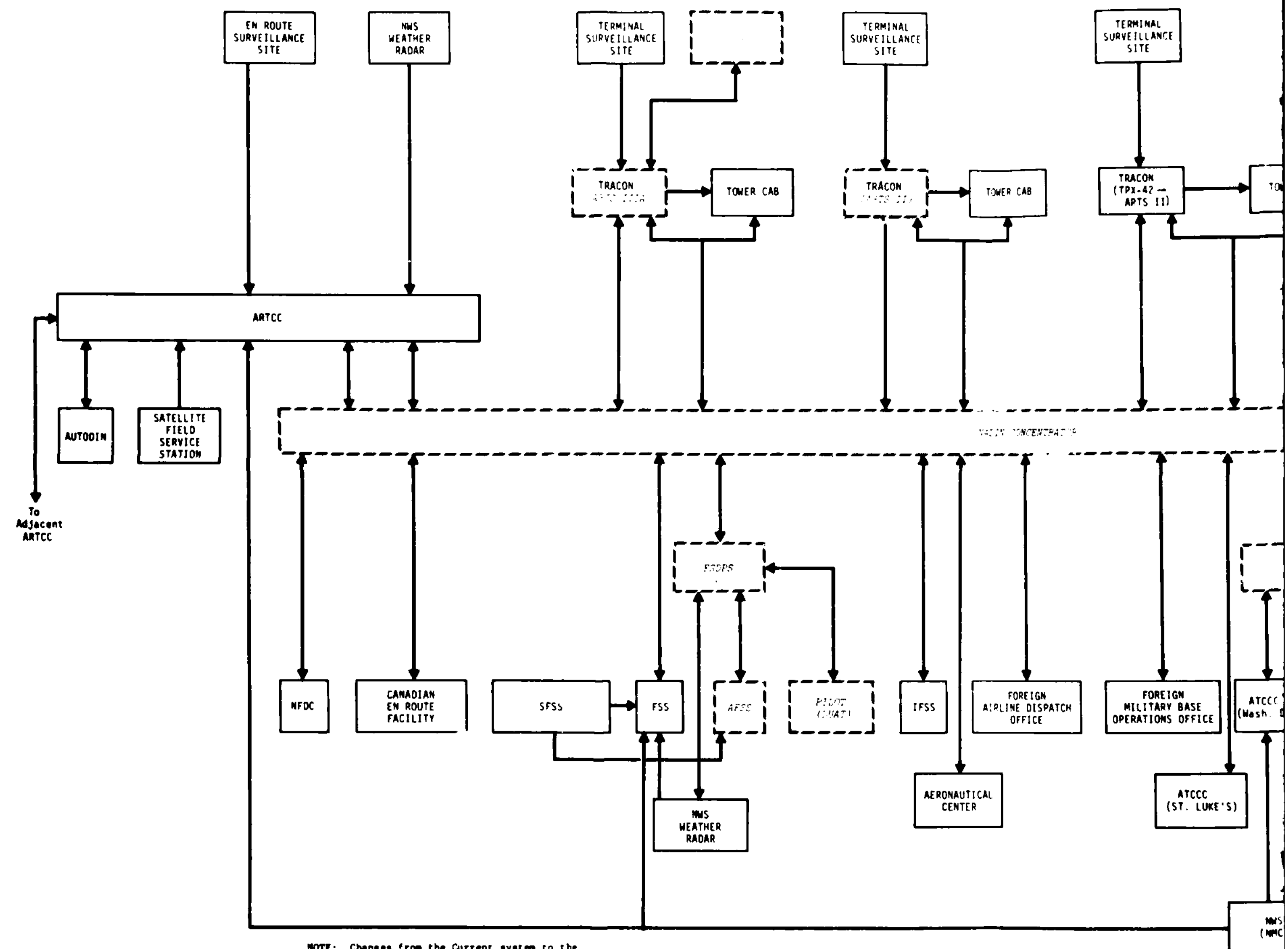
period. Data communications as of the end of the Near Term period will be as shown in Figure 9-15. It should be noted that during this period the Model 1 FSAS program will be implemented. Under this program, data communications to and from the Automated Flight Service Stations (AFSSs) will be routed through FSDPS. NADIN will not be used by the Model 1 FSAS. The Model 2 FSAS will provide further automation through incorporation of the Aviation Weather Processor (AWP), further refinement of the FSDPS, and a gradual phase out of the non-automated FSSs. The Direct User Access Terminal (DUAT) System will also be introduced in the Near Term.

Data communications in the Far Term will be as shown in Figure 9-16. During this period, further automation of the FSS environment occurs and the WMSC will be merged into the AWP. DABS will be introduced in the terminal environment. NEXRAD will also be introduced during the Far Term.

During the Far Term time period, it is assumed that all surveillance data will be transmitted in digital form from both en route and terminal surveillance sites over conventional voice bandwidth circuits. Broadband video surveillance information transmitted via coaxial cable or microwave facilities in the Near Term will either be replaced with new surveillance equipment (DABS, ARSR-9, etc.) or eliminated as backup equipment for existing digital surveillance facilities.

9.1.3 Tentative Data Communications Implementation Schedule

Current planning is to implement NADIN following the schedule shown in Figure 9-17.



NOTE: Changes from the Current system to the Near Term are indicated in *italics*

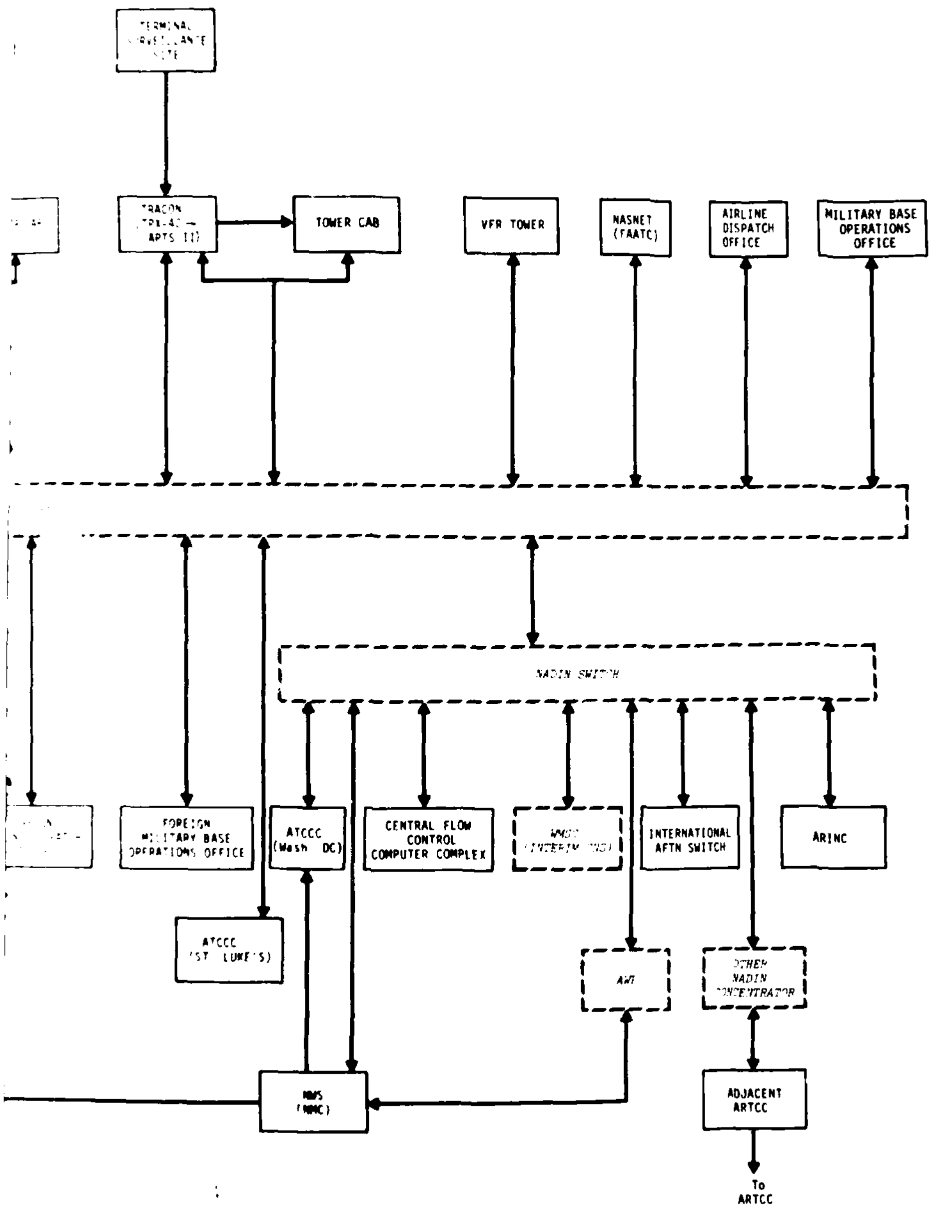
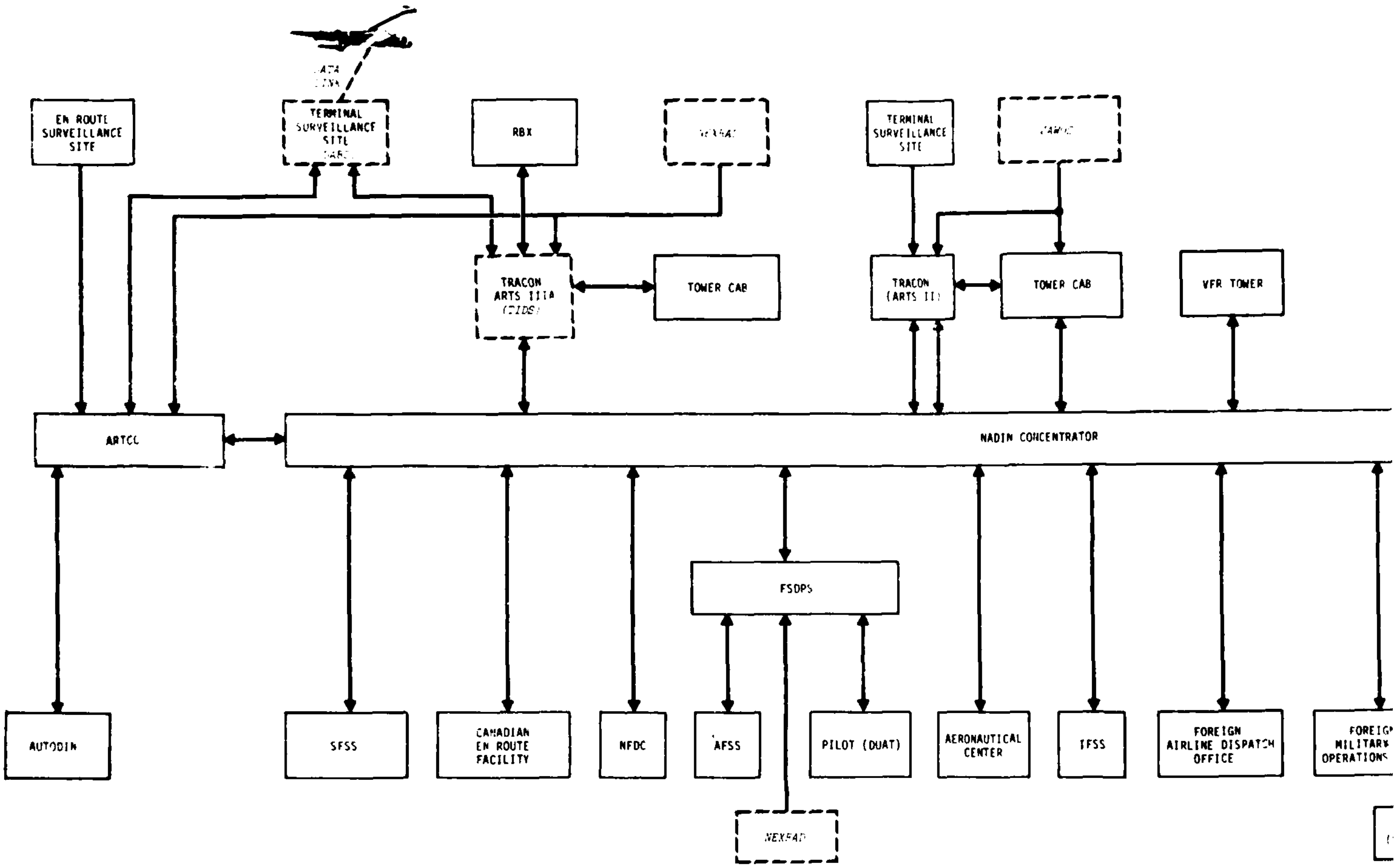


FIGURE 9-15
NEAR TERM DATA COMMUNICATIONS



<u>NOTE</u> Changes from the Near Term system to the Far Term are indicated in *italics*.

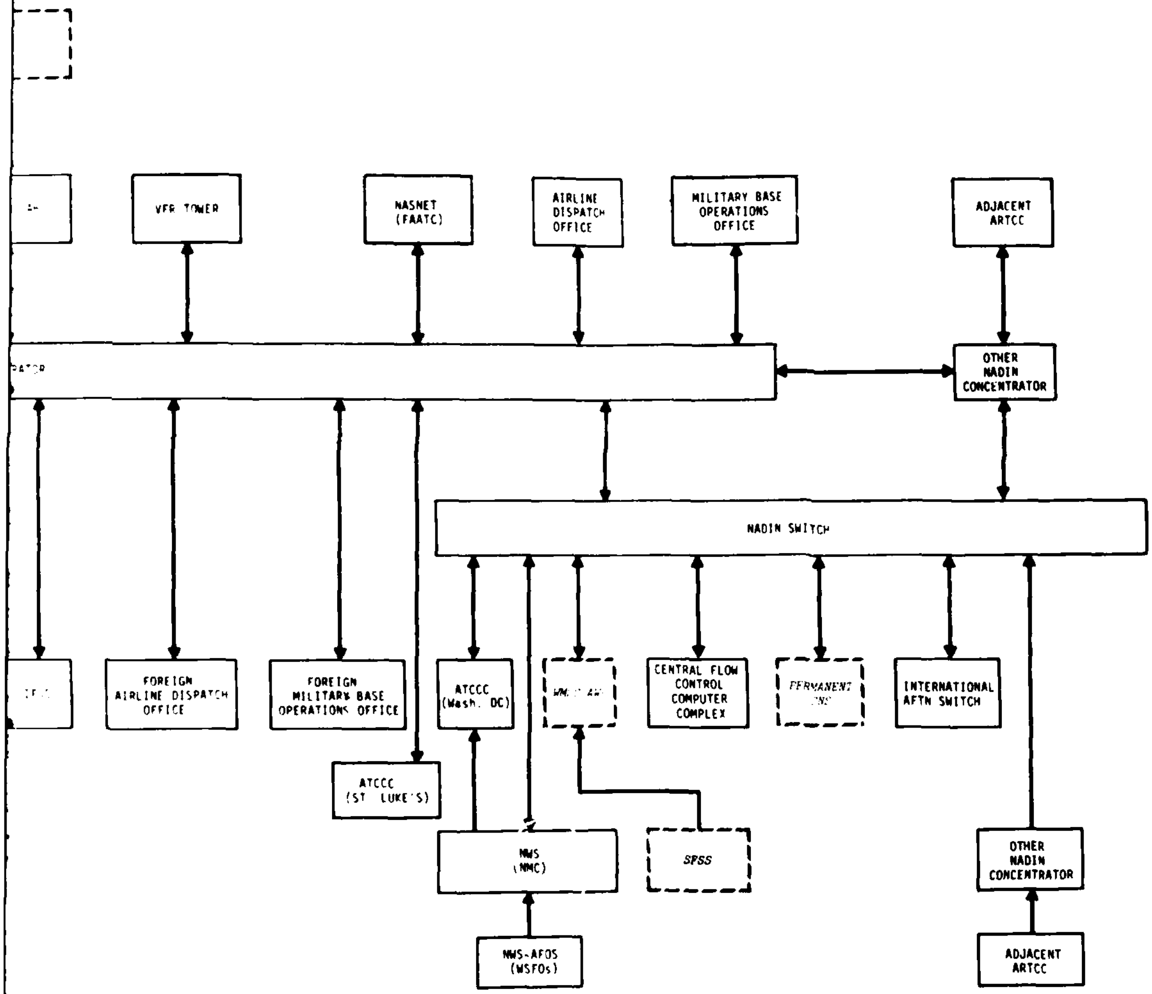
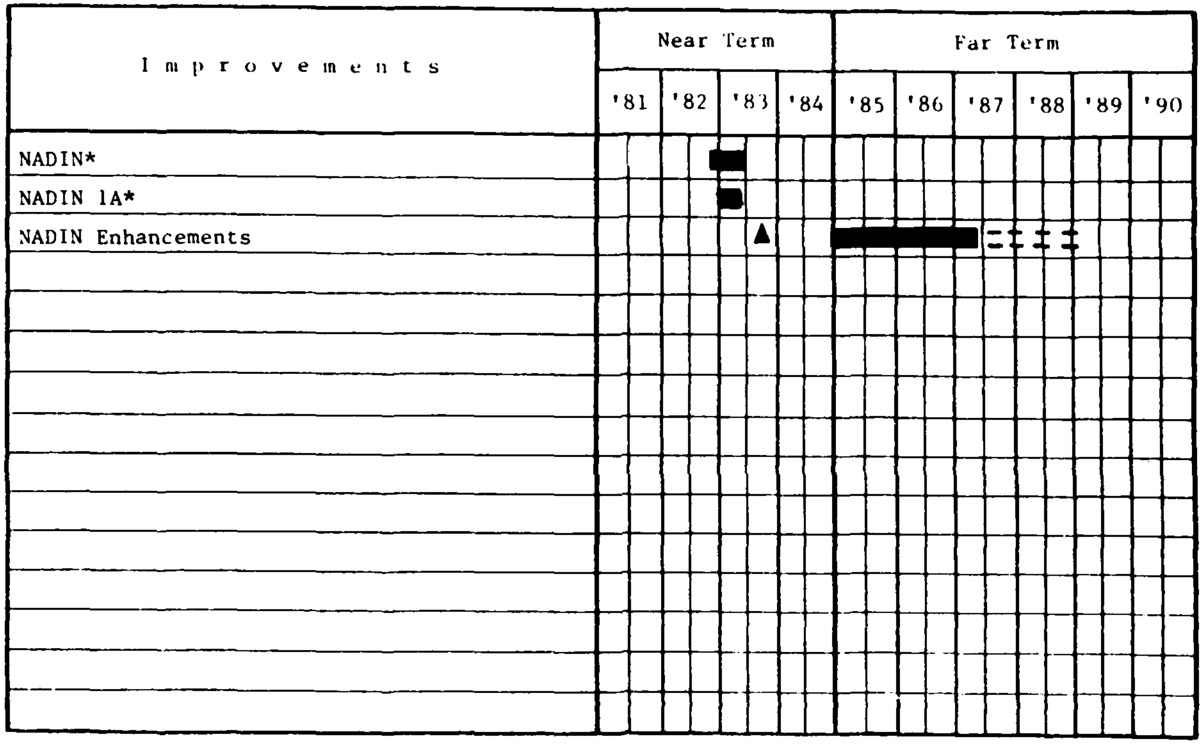


FIGURE 9-16
FAR TERM DATA COMMUNICATIONS



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 9-17
NADIN IMPLEMENTATION SCHEDULE

9.1.4 Data Communications Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in a particular facility, and how they would interact with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issue cited below was identified during the preparation of this document and was reviewed with the appropriate FAA program managers. Follow-up on this issue was undertaken by a joint System Research and Development Service and Airway Facilities Service group. The issue and assumptions stated below are consistent with the issue descriptions still under consideration by this group in early December 1980. The reader is cautioned to check for recent changes in the status of this issue before forming any final conclusions.

The integration issue assumption pertinent to Data Communications Facilities is:

Issue 905: NADIN Interface With TIDS and ARTS

ARD-200 will provide NADIN interface requirements for TIDS and ARTS III to ARD-100 to insure that the TIDS/ARTS III terminal system has an appropriate front-end processor and can accept the NADIN addressing scheme.

9.2 Voice Communications

This section describes the communications facilities that provide both air/ground and ground/ground voice communications for FAA ATC facilities operating in CONUS. Air/ground communications facilities provide voice communications between FAA operated ATC facilities and aircraft. Ground/ground communications facilities provide voice communications between FAA operated ATC facilities (and some non-FAA operated user locations, such as military base operations offices and airline dispatch offices), and among FAA personnel within an ATC facility. This description emphasizes those communications facilities directly related to the provision of ATC services. Administrative communications such as those provided by the Federal Telecommunications System (FTS) are not addressed.

Air/ground Communications Facilities provide connectivity between aircraft and the en route and terminal air traffic controllers through whose sectors the aircrafts fly. Other air/ground facilities provide connectivity between aircraft and Flight Service Station (FSS) specialists who maintain radio contact with the pilot for the communication of flight plan, weather, NOTAM, PIREP, NAVAID status and other en route advisory information. In addition, there are continuous scheduled and unscheduled air/ground broadcasts.

The ground/ground Communications Facilities provide connectivity among the en route centers, terminal facilities, flight service facilities and other non-FAA operated facilities such as military base operations offices and airline dispatch offices. The ground/ground voice communications system also provides

intra-facility connectivity between controllers (specialists) and their supervisory personnel. In addition, the ground/ground system provides pilots (on-the-ground) with access to controllers (specialists) and voice-recorded information.

9.2.1 Voice Communications Improvements Summary

Various improvements in the FAA voice communications facilities are in the planning or implementation stages. This section identifies major functional areas and the improvements planned for each of these areas. These improvements are briefly described for each of the major FAA environments (En Route, Terminal and FSS) in each of the time periods (Current, Near Term and Far Term) referenced throughout this document.

9.2.1.1 En Route Improvements

A summary of the basic voice communications functions and the proposed improvements in voice communications facilities and equipment for the en route environment is shown in Table 9-10. This table briefly outlines the en route air/ground (A/G) and ground/ground (G/G) voice communications facilities and equipment in the current time period, and the improvements which are planned for implementation in the Near Term and Far Term time periods which support these basic voice communications functions.

Air/ground communications between en route controllers and aircraft are accomplished through FAA-owned radio control systems at ARTCCs, Remote Center Air-Ground (RCAG) sites with VHF/UHF transmitters/receivers and antennas, and the associated

TABLE 9-10
EN ROUTE FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTIONS	CURRENT (1980)	NEAR TERM IMPROVEMENTS (1981-1984)	*FAR TERM IMPROVEMENTS* (POST-1984)
En Route Air/Ground Facilities			
• Controller to Pilot - Transmitters/Receivers	Mix of Solid State and Vacuum Tube TX/RCVs	Solid-State TX/RCVs*	NC
- *Transmission Facilities*	*Point-to-Point 1142 Conditioned* Transmission Facilities	*Point-to-Point* Unconditioned Transmission Facilities	Complete Near Term Implementation
- Antennas	VHF/UHF Antennas	Improved VHF/UHF Antennas*	NC
• Signaling	Tone Control	Solid-State Inband and Out-of-band Signaling and Control via *VSCS*	Complete Near Term Implementation
• *Monitoring, Reconfiguration* and Trunk Restoral	Line Automatic Sensing and Switching (LASS) in some facilities	Automatic Trunk Restoral	Automatic Reconfiguration via VSCS
	Manual Reconfiguration and Trunk Restoral	Remote Maintenance Monitoring System (RMMS) for Remote Site Monitoring and *Certification*	NC
• Backup Radio Communications	Backup Emergency *Communication* (BUEC), an independent radio system with remote sites at ARSRs, LRRs, RTRs, VORs, etc.	Provide BUEC Priority Indication to Controllers	NC
<u>En Route Ground-Ground Facilities</u>			
• En Route Controller to Other Facilities	*Service F Interphone Network with* Point-to-Point and Multi-point *facilities*	NC	NC
• En Route Controller to En Route Controller (Intercom)	Intercom via WECO 300 Key System	NC	Intercom via VSCS
• Switching and Signaling	WECO 300 Key System	NC	VSCS
• Monitoring, Reconfiguration and Trunk Restoral	Manual	NC	Automatic Reconfiguration and Trunk Restoral via VSCS

NC - No change included in current plans.
* - *Approved by the FAA for implementation*

lines and signaling, monitoring, reconfiguration and trunk restoral subsystems.

Until recently, RCAGs have exclusively used vacuum tube transmitters and receivers. A solid-state transmitter/receiver modernization program is nearly complete to replace the old vacuum tube transmitters and receivers with solid state equipment in all RCAGs.

Another improvement in A/G communications facilities in the en route environment is the implementation of the next generation UHF/VHF antennas. Requirements for increased A/G channel assignment with narrower bandwidth (25 KHz) and the use of lower transmitter power (10 watts instead of 50 watts) has led to the establishment of new FAA antenna standards (Reference 9-12). These new standards incorporate state-of-the-art antennas which are radomed and stacked, in some cases. The current antenna replacement program is ongoing and will continue through the Near Term time period.

The FAA-owned voice frequency signaling and control equipment which is currently operational at the ARTCCs and associated RCAGs has proven to be costly to maintain due to its obsolete technology. According to current plans, the Voice Switching and Control System (VSCS) (Reference 9-13) will replace this voice frequency signaling and control equipment with solid state equipment. This improvement is scheduled for implementation beginning in the Near Term with completion in the Far Term time period. Although VSCS concepts are being finalized at this time, one of the concepts incorporates inband digital signaling for the transmission of control signals and out-of-band

signaling for the transmission of status and monitored data (including remote certification data) to replace the present voice frequency signaling and control equipment. VSCS will also provide automatic reconfiguration and trunk restoral capability as a replacement for similar manual capabilities. The introduction of VSCS with inband signaling in the Near Term time period will also eliminate the requirement for 1142 conditioned transmission facilities between the ARTCC and the associated RCAGs. A significant annual savings in the cost of transmission facilities will be achieved through the use of unconditioned transmission facilities. Radio position equipment for controllers at en route ARTCCs will be provided in the Far Term and will not be part of the initial voice frequency and control equipment replacement program of VSCS.

Another en route improvement in the Near Term is in the area of remote maintenance monitoring. Currently, monitoring, reconfiguration and trunk restoral functions for air/ground communications are done manually in most facilities. However, some facilities have a monitoring/automatic trunk restoral system called the Line Automatic Sensing and Switching (LASS) system. This system was found to be too expensive for widespread use by the FAA and is currently being removed from the facilities that it services. The monitoring function will be enhanced in the Near Term by the implementation of the Remote Maintenance Monitoring System (RMMS) at sterile RCAGs, i.e., RCAGs not colocated with other FAA electronic facilities. Other RCAGs will be implemented in the Far Term. The RMMS consists of a Maintenance Processor System (MPS) located at the ARTCC or Airway Facilities Sector Office and Remote Monitoring Systems (RMS) located at remote radio sites. This system is part of an

overall program for remote maintenance and monitoring of RCAGs, surveillance sites, and VORTACs. The RCAG-Remote Monitoring System (RMS) in conjunction with MPS will provide automatic monitoring of operational equipment, environmental conditions and alarms for the en route environment. Remote certification, record keeping, trend analysis and data base capability will also be provided.

Although RCAGs provide the primary air-ground communications outlets for the ARTCCs, the FAA currently utilizes the BUEC (Back-Up Emergency Communications) system as a backup to the RCAG sites. Many BUEC transceivers are located at en route radar sites. ARTCC-BUEC site connectivity is accomplished by Radar Microwave Links (RML) and dedicated leased telephone facilities. In the Near Term, the BUEC system will be modified to provide BUEC priority indications to the controllers. These indicators at the position console identify the availability of specific BUEC sites which may be used to provide back-up frequencies to a controller at a particular sector. BUEC will also interface with the VSCS during the Near Term time period.

The en route ground-ground voice communications system consists of the networks that connect the en route center to other FAA facilities, the internal ARTCC intercom communications system connecting controller to controller and to supervisor, the switching/signaling systems, and systems conducting monitoring, reconfiguration and trunk restoral functions. The set of dedicated circuits that currently connect the en route centers to other FAA facilities is generally referred to as the Service F interphone network. This private network provides the connectivity between any ARTCC facility and other FAA facilities

in the conterminous U.S. It also provides connectivity between an ARTCC facility and other non-FAA facilities such as military base operations offices and airline dispatch offices.

The ground/ground voice switching and signaling functions currently performed at en route centers are provided by the WECO 300 Key System. This is electromechanical type equipment leased from AT&T. The monitoring, reconfiguration and trunk restoral functions are currently performed manually from patch panels by cross-connections. The en route portion of the VSCS program anticipated for the ARTCCs will replace the WECO 300 key systems. This implementation is scheduled to begin during the Far Term time period.

9.2.1.2 TRACON/Tower Improvements

A summary of the improvements in voice communications facilities and equipment for the TRACON/Tower environment is shown in Table 9-11. This table briefly outlines the TRACON/Tower air/ground (A/G) and ground/ground (G/G) voice communications facilities and equipment in the current time period, and the improvements which are planned for implementation in the Near-Term and Far Term time periods which support these basic voice communications functions.

Air/ground communications between TRACON/Tower controllers and aircraft are accomplished through FAA-owned radio control systems at TRACONs/Towers and either local VHF/UHF transmitters/receivers or Remote Transmitter/Receiver (RTR) sites. Until recently, the TRACON/Tower A/G facilities have exclusively used vacuum tube/relay radio equipment. A

TABLE 9-11
TERMINAL FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTIONS	CURRENT (1980)	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)
<u>Terminal Air-Ground Facilities</u>			
• Terminal Controller to Pilot			
- Transmitters/Receivers	Vacuum Tube TXs/RCVs	Solid-State TXs/RCVs*	Complete Near Term Implementation
- Transmission Facilities	Point-to-Point Unconditioned Transmission Facilities	NC	NC
- Antennas	VHF/UHF Antennas	Improved VHF/UHF Antennas	Complete Near Term Implementation
• Signaling	Tone or Direct Control	Solid-State Inband and Out-of-band Signaling and Control via VSCS	Complete Near Term Implementation
• Monitoring, Reconfiguration and Trunk Restoral	Manual Reconfiguration and Trunk Restoral	Monitoring and Automatic Reconfiguration and Trunk Restoral via VSCS	Complete Near Term Implementation
<u>Terminal Ground-Ground Facilities</u>			
• Terminal Controller to Other Facilities	Service F Interphone Network with Point-to-Point and Multipoint Facilities	NC	NC
• Switching and Signaling	WECO 300, 301 and Smaller Key Systems	VSCS	Complete Near Term Implementation
• Monitoring, Reconfiguration and Trunk Restoral	Manual	Automatic Reconfiguration and Trunk Restoral via VSCS	Complete Near Term Implementation

NC - No change included in current plans
* - Approved for FAA implementation

modernization program is currently underway to replace vacuum tube transmitters and receivers with solid-state equipment for all TRACON/Tower facilities. This program is ongoing and is scheduled for completion in the Far Term. Another planned improvement in A/G communications facilities in the terminal environment is the implementation of the next generation of VHF/UHF antennas. Requirements for increased A/G channel assignments with narrower bandwidth (25 KHz) and the use of lower transmitter power (10 watts instead of 50 watts) has led to the establishment of new FAA antenna standards (Reference 9-12). These new standards incorporate state-of-the-art antennas which are radomed and, in some cases, stacked. The current antenna replacement program will continue throughout the Near Term and into the Far Term.

The VSCS program will provide equipment to replace the FAA-owned voice frequency signaling and control equipment which is currently operational at TRACON/Tower sites and their associated local and remote transmitter/receiver (RTR) sites. The present equipment has proven to be costly to maintain due its obsolete technology and will be replaced by the solid-state VSCS equipment beginning in the Near Term time period. Implementation will not be completed until the Far Term. The VSCS program plans to refine the technology developed in the Small Voice Switching System (SVSS) program and utilize equipment based on this refined technology to replace the radio voice frequency signaling and control equipment, as well as the ground/ground voice communications equipment, in low-activity towers and TRACONs. This system is planned to be an integrated radio and G/G voice system which provides the signaling, switching, monitoring, reconfiguration and trunk restoral for

both the radio and G/G voice functions. Initial implementation in the terminal environment will begin in the Near Term with a small number (13) of large TRACON locations. Implementation at other locations will continue through the Far Term time period.

Transmission facilities between the TRACON/Tower sites and their associated RTR sites are currently point-to-point unconditioned lines with a small number of 1142 conditioned lines. VSCS will provide automatic reconfiguration of communications facilities.

The TRACON/Tower ground-ground voice communications with other facilities are currently provided via the Service F network. The voice switching and signaling is currently done by the WECO 301 and associated signaling equipment at high activity facilities or by small key systems such as the WECO 1A1 at low level facilities. Like the WECO 300, the WECO 301 and 1A1 key systems are electromechanical type equipment. The monitoring, reconfiguration and trunk restoral functions are currently done manually via patch panels or cross-connections. It is anticipated that the initial implementation of the integrated radio and G/G voice VSCS in the terminal environment will be started in the Near Term to replace the existing electromechanical equipment. The refined version of the SVSS system may also be used to replace the G/G and A/G communications equipment in low-activity TRACONs and towers. These implementations are not scheduled for completion until the Far Term.

9.2.1.3 FSS Improvements

A summary of the improvements planned for voice communications

in flight service station facilities is shown in Table 9-12. The table briefly describes the FSS A/G and G/G communications facilities in the current time period and the improvements which are expected to be implemented in the Near Term and the Far Term. In the Near Term, fifty-six (56) FSS facilities will be established with automation aids and will be referred to as Automated Flight Service Stations (AFSS). The automation data base and data processing capability will be provided at 14 Flight Service Data Processing Systems (FSDPS) located at selected ARTCCs in CONUS. In the Far Term, three (3) additional FSDPSs will be implemented at San Juan, Honolulu and Anchorage, along with five more AFSSs. Air/ground (A/G) communications between the FSS specialists and aircraft is accomplished through local VHF/UHF transmitters and receivers and transceivers or transmitters/receivers located at remote sites. Dedicated point-to-point transmission facilities connect the FSSs to these radio sites.

Direction Finder (DF) equipment and facilities are also provided at selected FSSs which are used for locating lost aircraft. An ongoing improvement program will provide new Doppler Direction Finding (DF) equipment in both the FSSs and associated remote DF sites. This initial DF program will provide equipment for 122 new DF sites. The implementation is scheduled for completion in the Near Term time period. A subsequent DF program will provide replacement DF equipment for the 173 currently operational sites. This program is scheduled for implementation during the Far Term.

FSSs also monitor navigational aids (NAVAIDs). These NAVAIDs which include VORs, VORTACs and Nondirectional Beacon (NDB)

TABLE 9-12
FLIGHT SERVICE FACILITIES VOICE COMMUNICATIONS IMPROVEMENTS SUMMARY

FUNCTIONS	CURRENT (1980)	NEAR TERM IMPROVEMENTS (1981-1984)	FAR TERM IMPROVEMENTS (POST-1984)
FSS Air-Ground Facilities			
• FSS Specialist to Pilot			
- Transmitters/Receivers	Vacuum tube TXs/RCVs at RCO, LRCO, VOR, RTR and Local Radio Sites	*Solid-State TXs/RCVs*	Complete Near Term Implementation
- Transmission Facilities	Point-to-Point Conditioned and Unconditioned Transmission Facilities	Point-to-Point Unconditioned Transmission Facilities	NC
- Antennas	VHF/UHF Antennas	Improved VHF/UHF Antennas	Complete Near Term Implementation
• FSS Specialist to Pilot via DF			
- Receiver	Vacuum tube RCVs at NDB sites	Solid-State RCVs	NC
- Transmission Facilities	Point-to-Point Unconditioned Transmission Facilities	NC	NC
• *Transcribed Weather* Broadcast (TWEB) to Pilot			
- Transmitters	Vacuum tube TXs at NDBs	Solid-State TXs	NC
- Transmission Facilities	Unconditioned Point-to-Point Transmission Facilities	NC	NC
• Signaling	Tone and Direct Control	Solid-State Inband and Out-of-band Signaling and Control via VSCS	NC
• Monitoring, Reconfiguration and Trunk Restoral	Manual Reconfiguration, Trunk Restoral and VOR Monitoring Capability	Expanded Monitoring Capability, Automatic Reconfiguration and Trunk Restoral via VSCS	NC
FSS Ground-Ground Facilities			
• FSS Specialist to Pilot (On the Ground)	DDD, WATS, FX and LX via various WECO key and ACD systems	DDD, WATS, FX and LX via VSCS equipped with ACD capability	NC
• FSS Specialist to Other Facilities	Service F network with Point-to-Point, Multipoint and Dial-up Facilities	NC	NC
• FSS Specialist to FSS Specialist (Intercom)	Intercom via various Key Systems	VSCS	NC
• Access to Voice Recorded Information (PATWAS, VRS, etc)	DDD, WATS, FX and LX access	DDD, WATS, FX and LX access via VSCS	NC
• *Switching and Signaling*	Key Systems	VSCS	NC
• Monitoring, Reconfiguration and Trunk Restoral	Manual	Automatic Reconfiguration, Trunk Restoral and Monitoring via VSCS	NC

NC - No change
* - Approved for FAA implementation

sites, have the capability to broadcast live and recorded weather and airport information, including Transcribed Weather Broadcasts (TWEB) and Notice to Airmen (NOTAM).

Most FSS A/G facilities currently use vacuum tube/relay radio equipment. A modernization program, currently underway to replace the vacuum tube transmitters and receivers with solid state equipment will be completed in the Far Term. New UHF/VHF antennas (Reference 9-12) will be deployed in the A/G communications facilities associated with Flight Service Stations. This FSS antenna replacement program is also scheduled for completion in the Far Term time period. New transmitters will also be implemented at NDB/VOR sites for TWEB operation.

The VSCS program will provide solid state radio control equipment for the 61 AFSSs and the associated remote radio sites. Interim communications for the first 12 to 15 AFSSs must be provided since VSCS for the AFSSs will not be available at the time of the initial AFSS cutovers. The VSCS program will also provide the equipment required in each of the non-automated FSSs to permit part-time FSS operation, although implementation of VSCS ground/ground voice and radio control equipment in non-automated FSSs is not planned. The monitoring, reconfiguration and trunk restoral functions that are currently done manually in the FSSs will be automated in the AFSSs with the advent of VSCS.

FSS ground/ground voice communications with other facilities are currently provided via the Service F network. Voice switching and signaling for both intercom and interphone calls is

currently provided by key equipment (such as the leased WECO 1A1 key system).

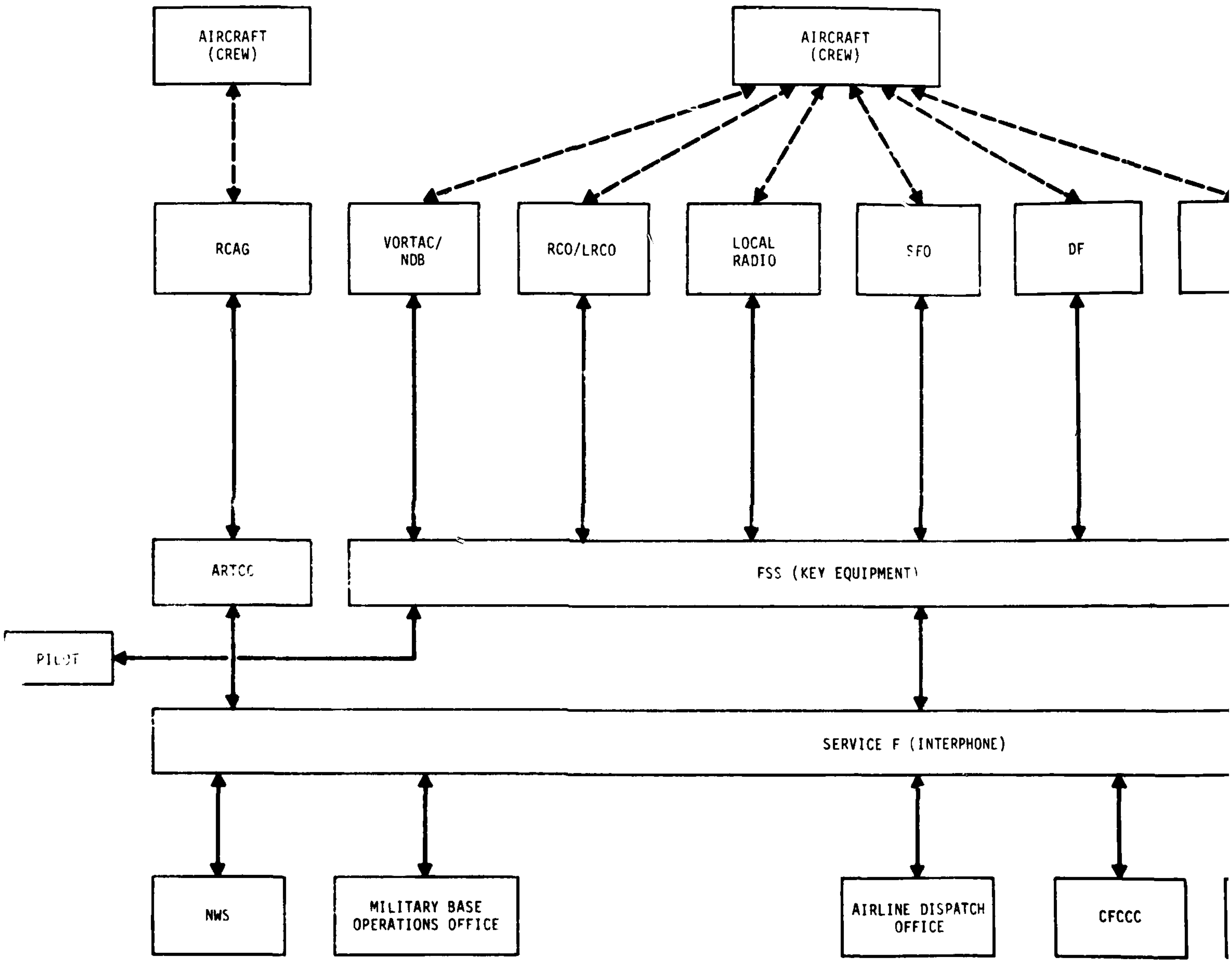
The introduction of VSCS in the FSS environment is planned during the Near Term which will replace the electromechanical and vacuum-tube radio and G/G voice control equipment with an integrated solid state switching system. VSCS will provide automatic reconfiguration and trunk restoral which are currently done manually.

Monitoring of remote site VSCS equipment will also be provided by VSCS. Implementation of VSCS in FSSs will be initiated during the Near Term time period with completion scheduled for the Far Term.

9.2.2 Voice Communications Connectivity

Figures 9-18, 9-19 and 9-20 illustrate the connectivity of the FAA's voice communication system in the Current, Near Term and Far Term time periods, respectively. Current FAA voice communications are shown in Figure 9-18. The Service F private line interphone network is shown with the primary control and remote facilities served.

FAA voice communications connectivity in the Near Term time period is shown in Figure 9-19. During the Near Term time period, VSCS will be introduced into the en route (voice frequency signaling and control equipment replacement only), terminal and FSS environments to replace the present electromechanical key equipment and the vacuum tube/relay radio control equipment. VSCS equipment will be implemented in some



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

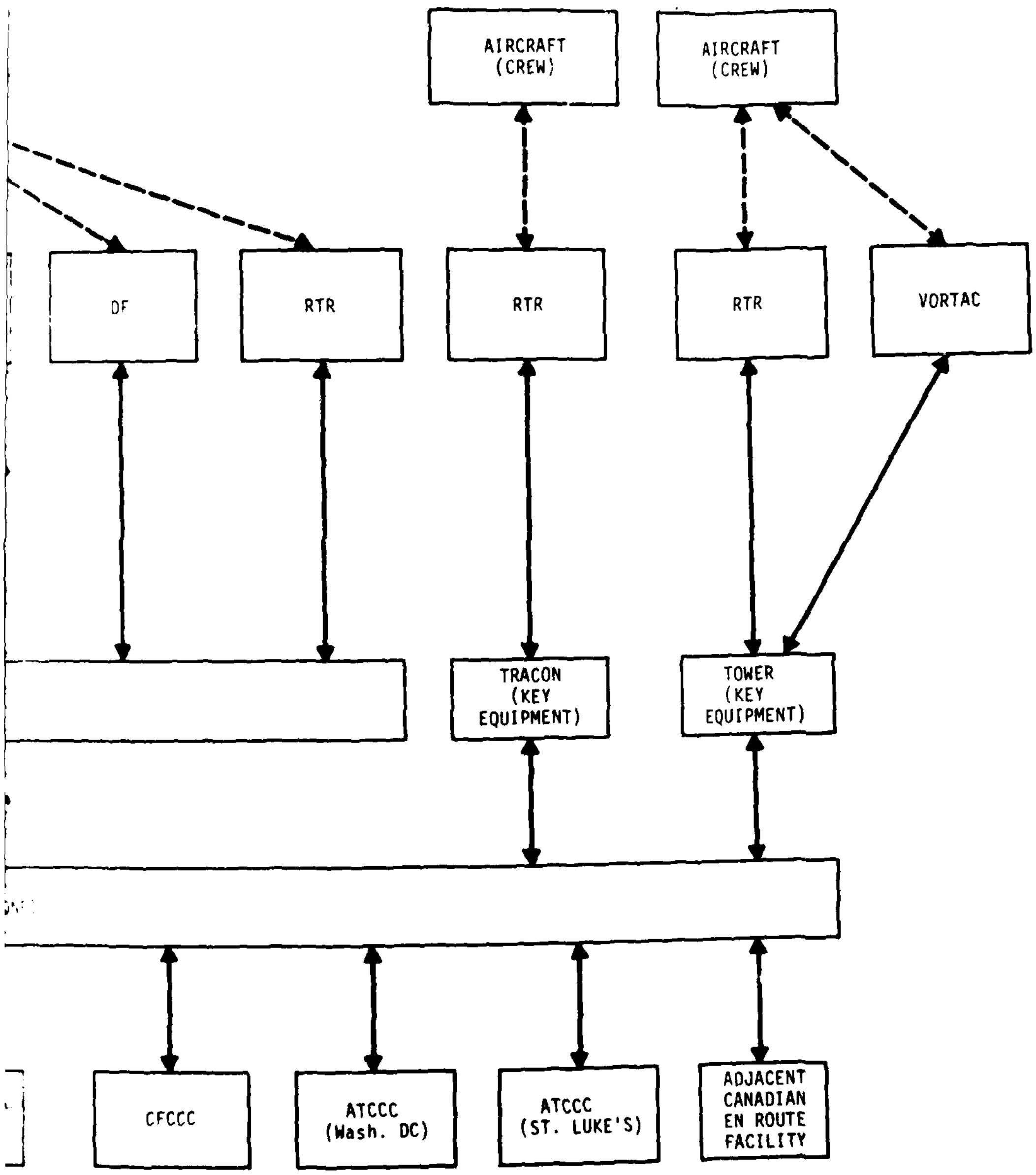
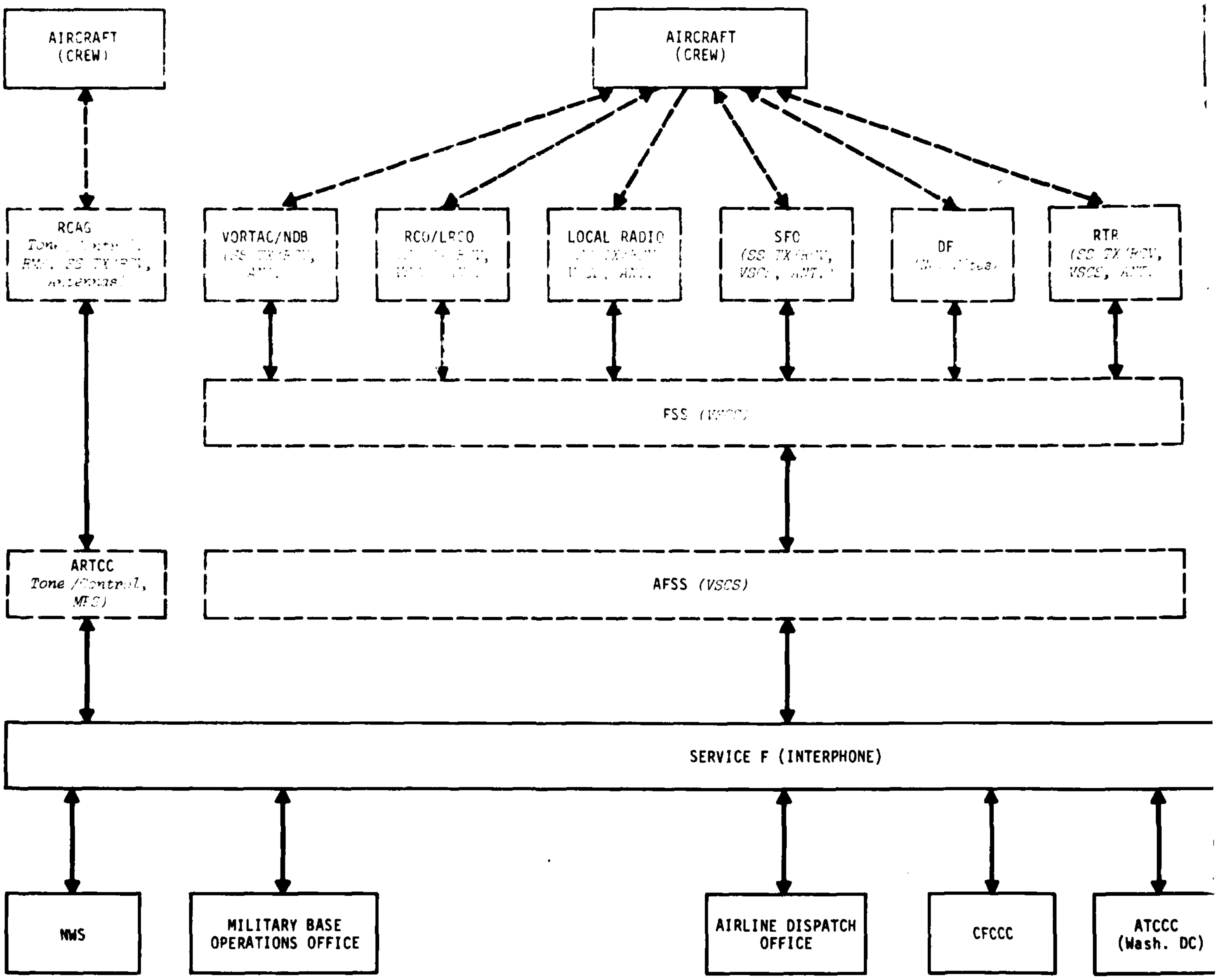


FIGURE 9-18
CURRENT VOICE COMMUNICATION CONNECTIVITY DIAGRAM

2



AIRCRAFT (CREW)
AIRCRAFT (CREW)
RCAG
VORTAC/NDB
RCO/LRCO
LOCAL RADIO
SFO
DF
RTR
FSS
ARTCC
AFSS (VSCS)
SERVICE F (INTERPHONE)
NWS
MILITARY BASE OPERATIONS OFFICE
AIRLINE DISPATCH OFFICE
CFCCC
ATCCC (Wash. DC)

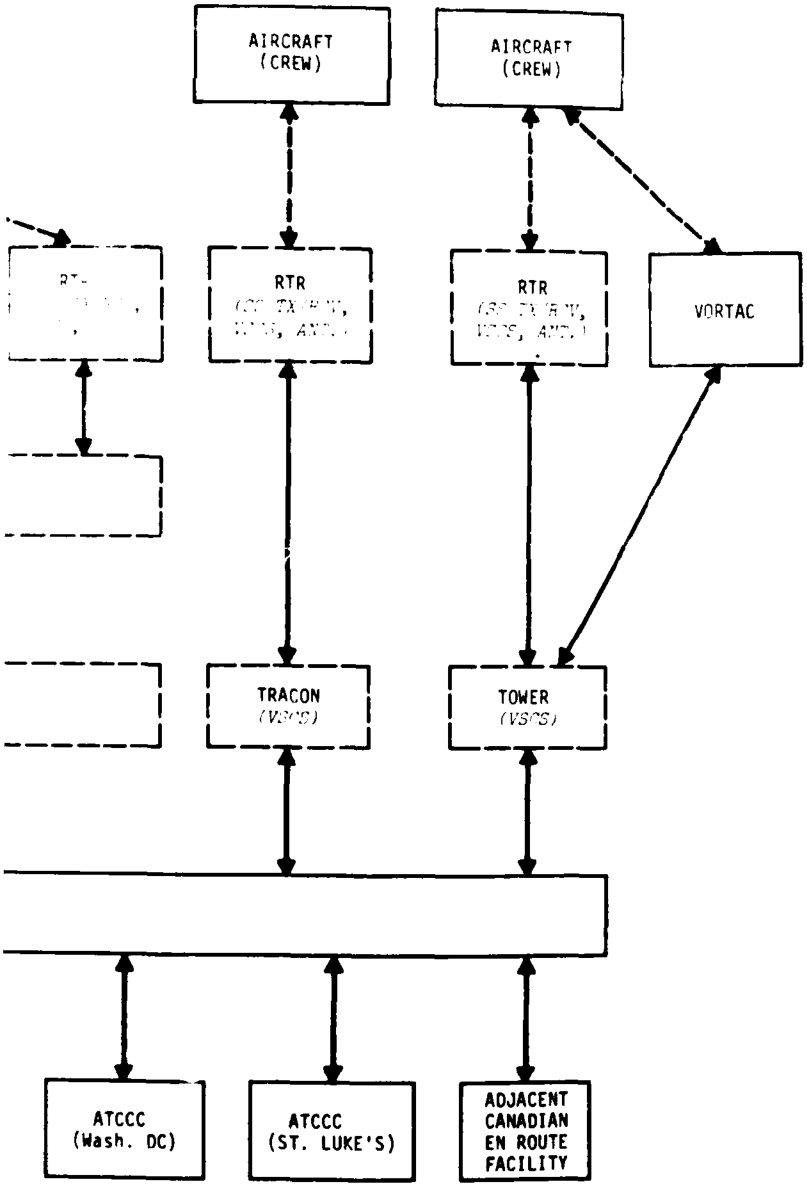
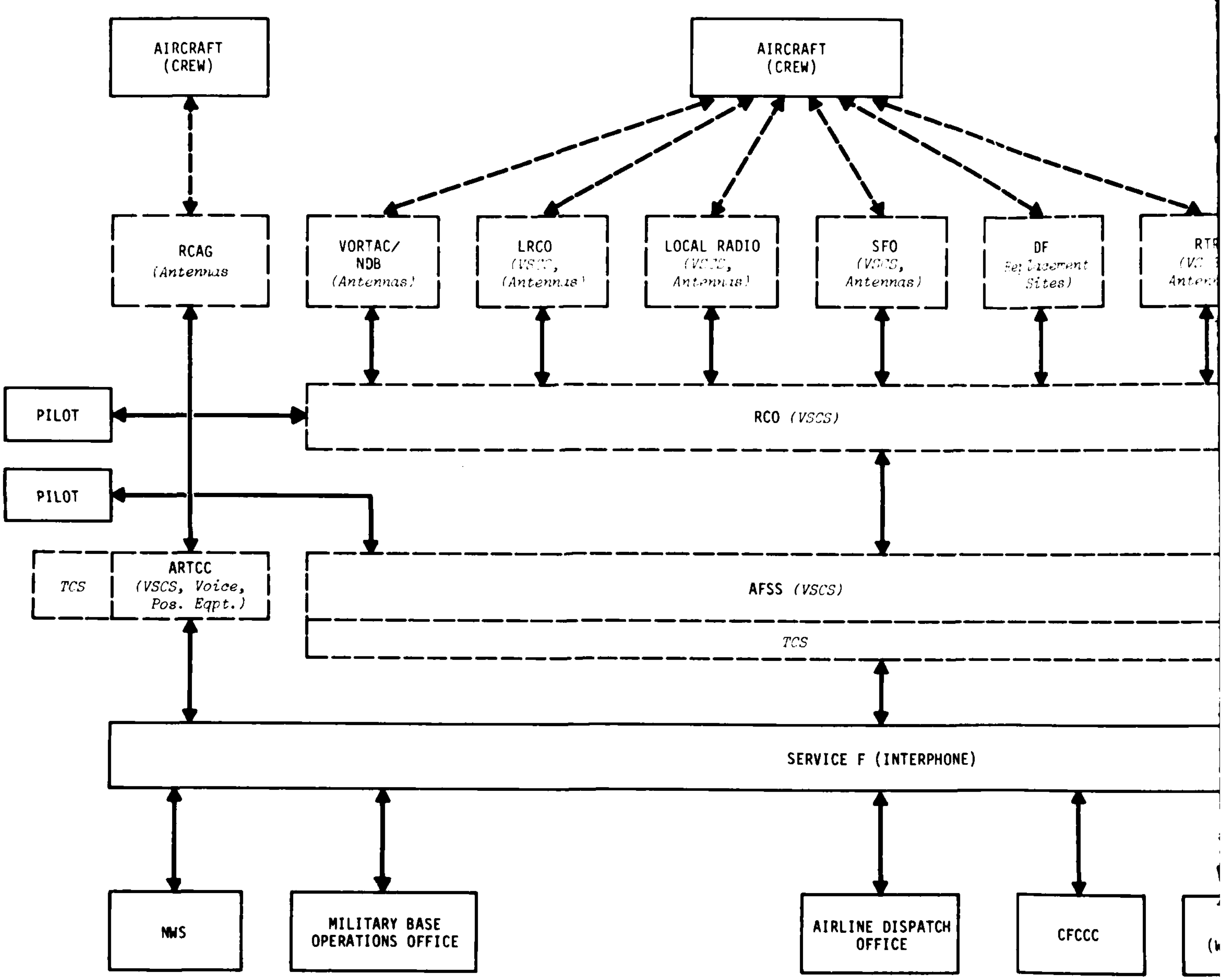


FIGURE 9-19
NEAR TERM VOICE COMMUNICATIONS CONNECTIVITY DIAGRAM

2



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

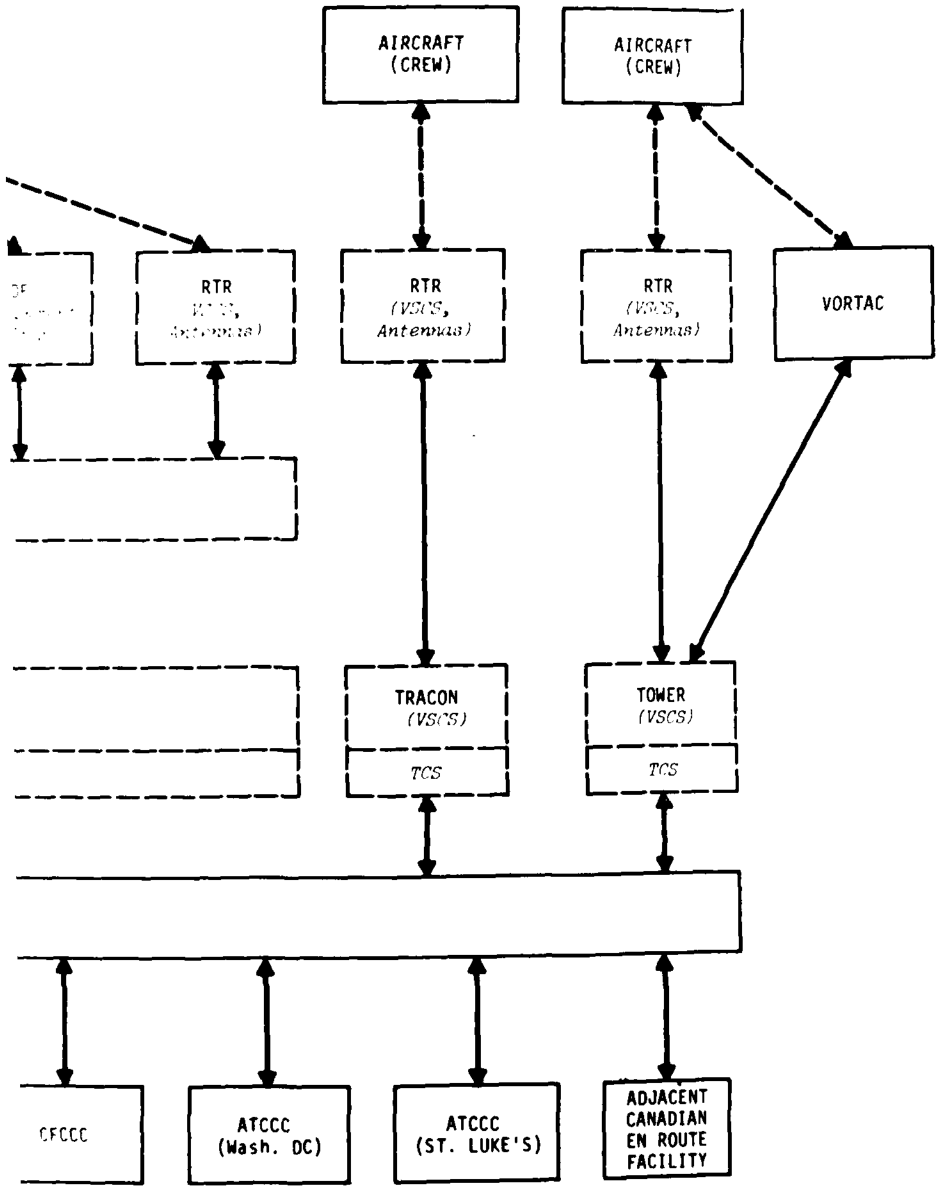


FIGURE 9-20
FAR TERM VOICE COMMUNICATIONS
CONNECTIVITY DIAGRAM

PRECEDING PAGE BLANK-NOT FILMED

of the new AFSS sites during this time period with completion scheduled during the Far Term time period. Implementation of the Maintenance Processor System (MPS) and Remote Monitoring System (RMS) will be initiated in the en route environment during this time period. Solid state transmitters and receivers will be implemented in the Near Term in most remote radio sites. Implementation will be completed during the Far Term time period. Initiation of the antenna replacement program will be started. New Doppler DF equipment will also be installed in 122 new DF sites during the Near Term.

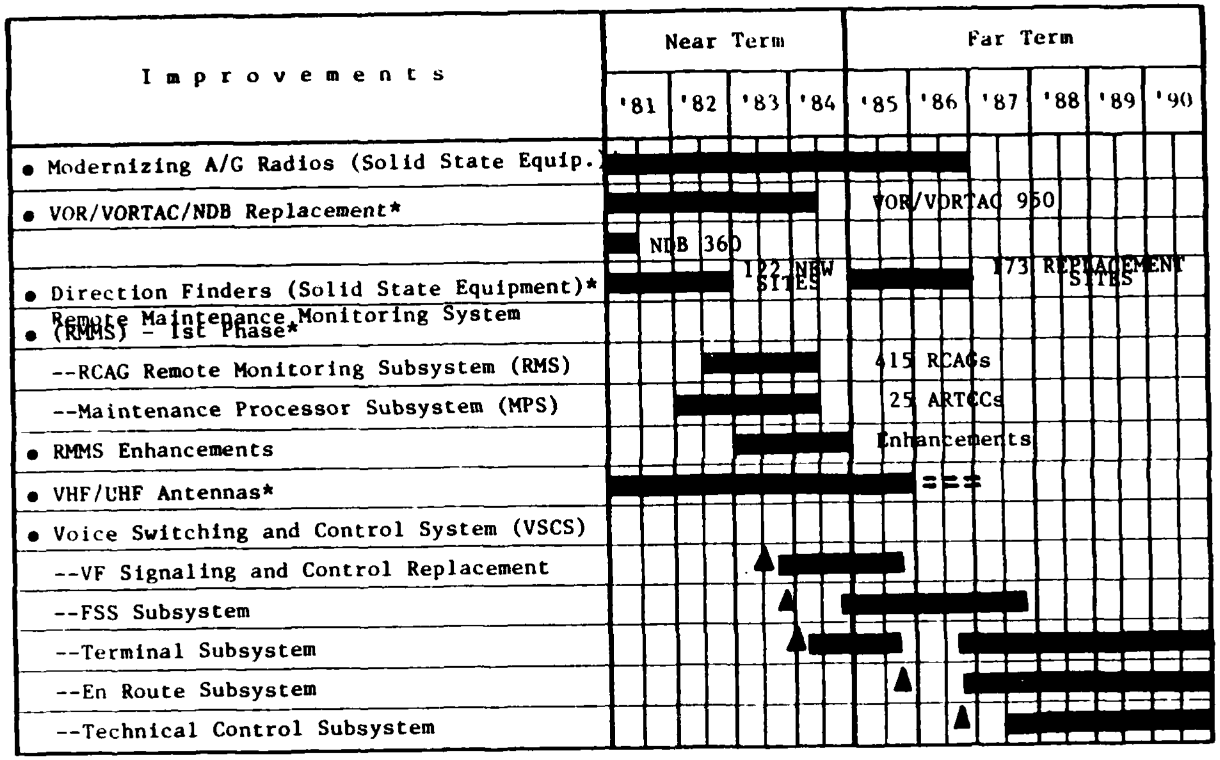
Figure 9-20 illustrates the FAA voice communications connectivity in the Far Term. Voice communications improvement highlights during the Far Term include completion of the VSCS program in all FAA environments, the introduction of the Technical Control Subsystem (TCS) of the VSCS program into control facilities, and completion of the transmitter/receiver and antenna replacement programs.

9.2.3 Voice Communications Tentative Implementation Schedule

Figure 9-21 presents the current implementation schedule, and, where known, the number of sites affected by the voice communications improvement.

9.2.4 Voice Communications Facilities Interface Planning Summary

In the preparation of this chapter it was necessary to make, or accept, a number of assumptions as to what improvements would be implemented, when they would be implemented, how they would function in a particular facility, and how they would interact



Note: Schedules are shown in Calendar Years. The implementation of an improvement is shown by a schedule bar that starts at the time that the first site will become operational and ends at the time that the last site will become operational.

* Approved for implementation

▲ = Technical Data Package Handoff

FIGURE 9-21
VOICE COMMUNICATIONS FACILITIES TENTATIVE IMPLEMENTATION SCHEDULE

with other facilities. This section identifies assumptions and areas of uncertainty by what are called "System Integration Issues."

The Integration Issues cited below were identified during the preparation of this document and were reviewed with the appropriate FAA program managers. Follow-up on these issues was undertaken by a joint System Research and Development Service and Airway Facilities Service group. The issues and assumptions stated below were consistent with the issue descriptions still under consideration by this group in early December 1980. The reader is cautioned to check for recent changes in the status of these issues before forming any final conclusions.

The integration issue assumptions pertinent to Voice Communications Facilities are:

Issue 103: RMMS Interaction With R&D Products

The interfaces required between RMMS and other systems currently being developed will be established in an evolutionary manner since these systems and RMMS are being developed concurrently. It is further assumed that ARD and AAF will mutually establish both equipment parameters to be monitored and certification parameters to be remoted for all new systems. Redundant monitoring and certification functions in the RMMS and other systems such as DABS and VSCS, will be eliminated to the extent feasible.

Issue 104: 1980 Maintenance Concept vs. System Complexity

It is assumed that the various ongoing and planned development systems will incorporate to the maximum extent possible the 1980s Maintenance Concept in order to minimize the overall manpower requirements. This requirement is particularly important in equipment developed for remote FAA facilities.

Issue 211: VSCS - 9020 Relationship

A General Purpose Input/Output (GPI/GPO) peripheral adapter module (PAM) will be used to provide the 9020 to VSCS interface. The VSCS will respond to reconfiguration commands generated by the 9020. A VSCS/9020 interface control document (ICD) will be developed by the VSCS contractor. Software changes in the 9020 that are required to establish this interface will be kept to a minimum.

Issue 215: VSCS - Tone Channeling Equipment Interface

Tone channel equipment for the ARTCC/RCAG environment will be provided in the initial technical data package developed in the VSCS program. The technical data package will be delivered to AAF by ARD by mid CY 83. Implementation is scheduled from the third quarter of CY 83 to the third quarter of CY 85. It is assumed that AAF will not proceed with an independent development and production of the proposed tone channel equipment.

Issue 604: VSCS Support to AFSSs

The assumption is that VSCS will provide voice communications (radio and ground/ground) for the proposed 61 consolidated AFSSs, however, the VSCS program is proceeding slowly with the FSS portion currently scheduled for the second Technical Data Package. The problem is further complicated by the uncertainty about the amount and kind of consolidation to be carried out for the AFSSs, and the time phasing of the consolidations. VSCS contract award is planned in early 1982 with late 1983 delivery. Since the AFSS schedule precedes this schedule, interim communications must be provided for the first 12 to 15 AFSSs. VSCS will be implemented in these sites following the implementation of the other AFSSs.

Issue 606: Voice Communications Equipment for Non-Automated FSSs

The VSCS program, as presently structured, will not provide radio or ground/ground voice communications equipment for the non-automated FSSs. It is assumed that, in accordance with the present VSCS specification, VSCS will provide non-automated FSSs capability to remote both existing radio and ground/ground voice communications facilities back to an associated AFSS and allow part-timing operation at the non-automated FSS.

Issue 607: Part-Time Use of Non-Automated FSSs

The current VSCS specification requires and this description of Voice Communications Facilities assumes that both radio and ground/ground voice communications equipment and support will be provided to AFSSs to permit part-time operation of non-automated

FSSs. However, operators of the Flight Service Stations have expressed reservations with regard to the projected cost savings which may be achieved from part-timing.

APPENDIX A

SOURCE DOCUMENTS

1-1. Federal Aviation Administration, "Definition, Description, and Interfaces of the FAA's Developmental Programs," FAA-EM-78-16, Washington, D.C., September 1978.

1-2. Federal Aviation Administration, "An Overview and Assessment of Plans and Programs for the Development of the Upgraded Third Generation Air Traffic Control System," FAA-EM-75-5, Revision 1, Washington, D.C., March 1975.

2-1. Computer Sciences Corporation, "Preliminary Computer Program Functional Specification for En Route Minimum Safe Altitude Warning (E-MSAW)," CSC/TM-79/6087, Atlantic City, New Jersey, May 1979.

2-2. Computer Sciences Corporation, "System Design Data for Model A3d2.4 En Route Minimum Safe Altitude Warning," CSC/TM-79/6008, Atlantic City, New Jersey, January 1979.

2-3. Swett, C. F., "A Design Concept for an IPC Airspace Protection Capability," The MITRE Corporation, MTR-7247, McLean, Virginia, July 1976.

2-4. Swett, C. F., "IPC Terrain Avoidance: Feasibility Study and Preliminary Design," The MITRE Corporation, MTR-7276, McLean, Virginia, February 1977.

2-5. Swett, C. F., "Design Concept for an Obstacle Avoidance Service," The MITRE Corporation, MTR-7432, McLean, Virginia, July 1977.

2-6. Computer Sciences Corporation, "Preliminary Computer Program Functional Specifications (CPFS) for En Route -- Minimum Safe Altitude Warning (E-MSAW)," DOT-FA76WA-3185, Atlantic City, New Jersey, March 1978.

2-7. Levin, K. M., and Zech, N. J., "En Route Metering Functional Specification," The MITRE Corporation, MTR-79W00155, Revision 2, McLean, Virginia, September 1980.

2-8. Sokkappa, B. G., and Ball, R. H., "Functional Description of En Route Metering," The MITRE Corporation, WP-12542, McLean, Virginia, August 1977.

2-9. Hauser, S. J., Jr., Dodge, P. O., and Steinbacher, J. G., "Computer Program Functional Specifications for En Route Conflict Alert," The MITRE Corporation, MTR-7311, McLean, Virginia, September 1976.

2-10. Steinbacher, J. G., Hauser, S. J., "En Route Conflict Alert: Specification for Conflict Detection Between Uncontrolled Mode C Targets and Controlled Aircraft," The MITRE Corporation, MTR-7456, McLean, Virginia, February 1977.

2-11. Dieudonne, J., "ATARS: A Functional Description," The MITRE Corporation, MTR-80W00101, McLean, Virginia, (Federal Aviation Administration, FAA-RD-80-46), April 1980.

2-12. Dieudonne, J., Lautenschlager, R., "DABS/ATARS/ATC Operational Systems Description," The MITRE Corporation, MTR-79W00436, McLean, Virginia, (Federal Aviation Administration, FAA-RD-80-42), April 1980.

2-13. Lentz, R. H., et al., "Automatic Traffic Advisory and Resolution Service (ATARS) Multi-site Algorithm," The MITRE Corporation, MTR-80W00100 (FAA-RD-80-3), McLean, Virginia, April 1980.

2-14. Lucier, E., "ATARS Traffic Advisory Service," Federal Aviation Administration, FAA-RD-80-43, Washington, D. C., April 1980.

2-15. Federal Aviation Administration, "ATC Facility Hardware Interfaces for DABS," FAA-RD-80-38, Washington, D. C., April 1980.

2-16. Federal Aviation Administration, "DABS Front End processor/En Route Central Computer Complex Protocol," FAA-RD-80-37, Washington, D. C., April 1980.

2-17. DeMeo, J., "DABS/ATC Facility Surveillance and Communications Message Formats," Federal Aviation Administration, FAA-RD-80-14, ATC-33, Washington, D. C., April 1980.

2-18. Todd, R. E., Ebert, P. M., "Active Beacon Collision Avoidance System," The MITRE Corporation, MP-79W31, McLean, Virginia, May 1980.

2-19. Grupe, J. A., et al., "Active Beacon Collision Avoidance System -- Detailed Collision Avoidance Algorithms," The MITRE Corporation, MTR-80W00826, McLean, Virginia, May 1980.

2-20. Ebert, P. M., "A Description of Passive BCAS Without North-Pulses, and a Sequential Tracking Algorithm," The MITRE Corporation, MTR-7751, McLean, Virginia, February 1978.

2-21. Hauser, S. J., Cunningham, R. L., Oei, L. S., Schuster, E. M., and Sundaram, S., "En Route Conflict Resolution Advisories: Functional Design Specification, Coordination Draft," The MITRE Corporation, MTR-80W00137, McLean, Virginia, April 1980.

2-22. Celio, J. C., "Electronic Tabular Display Subsystem (ETABS) Engineering Model: Project Management Plan," The MITRE Corporation, MTR-79W00142, McLean, Virginia, December 1979.

2-23. Celio, J. C., "Electronic Tabular Display Subsystem (ETABS) Engineering Model: Specification Updates," The MITRE Corporation, MTR-79W00452, McLean, Virginia, January 1980.

2-24. Manison, W. A., Amato, R. A., Kelley, J. P., Lawrence, M. M., Morgenstern, O. L., "Electronic Tabular Display Subsystem (ETABS) Engineering Model Specifications," The MITRE Corporation, MTR-7620, MTR-7621, McLean, Virginia, January 1978.

2-25. Federal Aviation Administration, "Acquisition Paper for an Electronic Tabular Display Subsystem (ETABS), ARD Subprogram 122-12," Washington, D. C.

2-26. Federal Aviation Administration, "Engineering Requirement, Electronic Tabular Display Subsystem Engineering Model," FAA-ER-110-208, Washington, D. C., 20 January 1978.

2-27. Raytheon Company, "Direct Access Radar Channel (DARC), Preliminary Design Data," DARC-8, Sudbury, Massachusetts, 22 December 1976.

2-28. Hilton, R. "Data Link Program Concept Paper," Federal Aviation Administration, Washington, D. C., June 1978.

2-29. Federal Aviation Administration, "Aviation Weather System Program Plan," Aviation Weather System Planning Team, Third Draft, Washington, D. C., April 1978.

2-30. Rucker, R. A., "Automated En Route ATC (AERA): Operational Concepts, Package 1 Description, and Issues," The MITRE Corporation, McLean, Virginia, MTR-79W00167, May 1979.

2-31. Horowitz, B. M., "Advanced En Route Air Traffic Control Automation," The MITRE Corporation, Paper Presented at EASCON, McLean, Virginia, September 1978.

2-32. Goldmuntz, L. G., et al., "The AERA Concept," Federal Aviation Administration, Draft, Washington, D. C., 1 December 1980.

2-33. Federal Aviation Administration, "The FAA Plans and Programs for the Future Airport and Air Traffic Control System," Washington, D. C., 13 November 1980.

2.34. Dukes, D. L., James, W. T., Sciambi, R. K., Swetnam, G. F., "Functional Characterization of an ATC Planning and Control Automation Concept," The MITRE Corporation, WP-80W00230, Revision 2, McLean, Vifginia, December 1980.

3-1. Federal Aviation Administration, "ARTS III System Description," SPO-MD-600, Washington, D.C., 3 August 1970.

3-2. Federal Aviation Administration, "ARTS III Computer Program Functional Specification," Model-Version AA0.12, Change 1, Washington, D. C., 1 July 1976.

3-3. Sperry UNIVAC, "ARTS IIIA Systems Design Data," ATC-23000, Final Report, St. Paul, Minnesota, December 1977.

3-4. Department of Transportation, Federal Aviation Administration, "Specification for ARTS IIIA Improvements to the Modularly Expandable ARTS IIIA Beacon Tracking Level System," FAA-E-2593a, Washington, D. C., July 1, 1976.

3-5. Selander, J. H., "System Test Scenarios for the Automated Radar Terminal System (ARTS) IIIA," The MITRE Corporation, MTR-79W00097, McLean, Virginia, April 1979.

3-6. Sperry UNIVAC, "The New York TRACON Design Data," ATC-25000, Preliminary Report, St. Paul, Minnesota,October 1977.

3-7. Sperry UNIVAC, "The New York TRACON Supplement to the ARTS IIIA Systems Design Data," ATC-25000, Final Report, St. Paul, Minnesota, June 1978

3-8. Federal Aviation Administration, "An Expanded ARTS IIIA System for the New York TRACON," FAA-E-2594a, Washington, D. C., 1 July 1976.

3-9. Schneider, R. E., Feldman, A. S, "New York TRACON (NYT) Memory Utilization Study," The MITRE Corporation, MTR-79W00308, McLean, Virginia, September 1979.

3-10. Miskill, D. K., "ATARS/ATC (Terminal) Phase I Testing: Software Requirements for the ARTS All-Digital System (ADS)," The MITRE Corporation, MTR-79N00005, Revision 1, McLean, Virginia, May 1980.

3-11. Asch, A., "Integration Plan, Automated Radar Terminal System, ARTS II," The MITRE Corporation, MTR-7182, McLean, Virginia, April 1976.

3-12. Federal Aviation Administration, "Operational System Description of the ARTS II System," Washington, D. C., April 1974.

3-13. Federal Aviation Administration, "Maintenance of AN/TPX-42A(V)4 Interrogator Set and Associated Display Equipment," Order 6360.9, Washington, D. C., 2 December 1976.

3-14. Federal Aviation Administration, "Terminal Information Processing System (TIPS): System Description," Washington, D. C., November 1977.

3-15. Miskill, D. K., "Technical Performance of the ARTS IIIA Tracking Function," The MITRE Corporation, MTR-7300, McLean, Virginia, January 1977.

3-16. Miskill, D. K., Vass, D. B., "Technical Performance of the Thresholded Alpha Beta Gamma (TABG) Tracker," The MITRE Corporation, MTR-79N00006, McLean, Virginia, October 1979.

3-17. Sperry UNIVAC, "DABS/SRAPII/ARTS III Design Data," Sperry UNIVAC, Defense Systems Division, ATC-10300, Revision C (Interim Report), St. Paul, Minnesota, July 1979.

3-18. Sperry UNIVAC, "Design Data for Conflict Alert Stage 1," Sperry UNIVAC Defense Systems Division, ATC 10410, St. Paul, Minnesota, May 1977.

3-19. Hauser, S. J., Jr., Miskill, D. K., Vass, D. B., "Terminal Area Conflict Alert: Design Verification Test Results," The MITRE Corporation, MTR-7677, McLean, Virginia, January 1978.

3-20. Hilton, R., "Data Link Program Concept Paper," Federal Aviation Administration, Washington, D.C., June 1978.

3-21. Federal Aviation Administration, "MSAW Data Base Parameters Automated Radar Terminal System, ARTS III," National Terminal Data Systems Branch (AAT-550), D3621B, Washington, D.C., September 1976.

3-22. Sperry UNIVAC, "Minimum Safe Altitude Warning Design Data," PX-11325, Rev. B, St. Paul, Minnesota, March 1977.

3-23. Sperry UNIVAC, "Metering and Spacing -- ARTS III, Design Data," PX-11123, Revision 6, St. Paul, Minnesota, January 1980.

3-24. Federal Aviation Administration, "Aircraft Collision Avoidance: Concepts and Systems," Papers from 1980 WESCON Professional Program, Washington, D. C., October 1980.

4-1. Hutcheson, R., et al., "Next Generation Weather Radar (NEXRAD) Joint Program Development Plan," MTR-80W138, The MITRE Corporation, McLean, Virginia, July 1980.

4-2. Bales, R., Waigand, F., "Hybrid Tower Automated Ground Surveillance (TAGS) System Definition," MTR-79W00394, The MITRE Corporation, McLean, Virginia, February 1980.

5-1. Beeker, G. G., "The Central Flow Control System Requirements," The MITRE Corporation, MTR-7258, McLean, Virginia, June 1976.

5-2. Bales, R. A., Beeker, G. G., Gabrieli, H. S., Morgenstern, O. L., and Watson, R. H., "Central Flow Control Computer Program Specifications," The MITRE Corporation, MTR-7293, Volumes I-IV, McLean, Virginia, September 1976.

5-3. Federal Aviation Administration, "The FAA Plans and Programs for the Future Airport and Air Traffic Control System," Washington, D. C., 13 November 1980.

5-4. Dukes, D. L., James W. T., Sciambi, R. K., Swetnam, G. F., "Functional Characterization of an ATC Planning and Control Automation Concept," The MITRE Corporation, WP-80W00230, Revision 2, McLean, Virginia, December 1980.

6-1. Federal Aviation Administration, "Master Plan, Flight Service Station Automation Program," FSS-01A, Washington, D.C., January 1978.

6-2. Federal Aviation Administration, "Master Plan Addendum, Flight Service Station Automation Program," FSS-01A1, Washington, D.C., March 1980.

6-3. Federal Aviation Administration, "System Description, Flight Service Information System (FSIS)," Coordination Draft, FSS-04, Washington, D.C., August 1977.

6-4. Federal Aviation Administration, "Specification for the Flight Service Automation System, Volume I, Model 1 and Model 2 System and Hardware," FAA-E-2683a, Washington, D.C., 7 August 1980.

6-5. Federal Aviation Administration, "Specification for the Flight Service Automation System, Volume II, Model 2 Software," Coordination Draft, FAA-E-2684a, Washington, D.C., 7 August 1980.

6-6. Federal Aviation Administration, "Specification for the Flight Service System, Volume III, Model 1 Software and Hardware," FAA-E-2685a, Washington, D.C., 7 August 1980.

6-7. Federal Aviation Administration, "Aviation Weather System Engineering and Development Program Plan," Draft, Washington, D.C., May 1980.

6-8. Federal Aviation Administration, "En Route Flight Advisory Service (EFAS)", Order 7110.51B, Washington, D.C., 9 March 1977.

6-9. Federal Aviation Administration, "En Route Flight Advisory Service (EFAS)," Order 7110.51B CHG 1, Washington, D.C., 27 May 1977.

6-10. Federal Aviation Administration, "Flight Service Information Systems Operational/Functional Requirements, Model 2," AAT Draft, Washington, D.C., 12 August 1977.

6-11. Federal Aviation Administration, "Flight Service Automation System Implementation Plan," FSS-05, Washington, D.C., August 1979.

7-1. Cartledge, L., and O'Donnell, R. M., "Description and Performance Evaluation of the Moving Target Detector," Lincoln Laboratory, ATC-69, Lexington, Massachusetts, 8 March 1977.

7-2. Hutcheson, R., et al., "Next Generation Weather Radar (NEXRAD) Joint Program Development Plan," MTR-80W138, The MITRE Corporation, McLean, Virginia, July 1980.

7-3. Dieudonne, J.E., Lautenschlager, R. W., "DABS/ATARS/ATC System Operational Description," MTR-79W00436, The MITRE Corporation, McLean, Virginia, April 1980.

8-1. Federal Aviation Administration, "Time Reference Scanning Beam Microwave Landing System, Introduction and Summary," Section 1, Washington, D.C., October 1977.

9-1. Beeker, G. G., "Air Traffic Control System Command Center System Description," The MITRE Corporation, WP-12693, Mclean, Virginia, December 1977.

9-2. Beeker, G. G., "Terminal Information Processing System (TIPS): NAS En Route Input/Output Requirements," The MITRE Corporation, MTR-7161, Volume 4, McLean, Virginia, March 1976.

9-3. Beeker, G. G., "Terminal Information Processing System (TIPS): ARTS-III Input/Output Requirements," The MITRE Corporation, MTR-7161, Volume 5, McLean, Virginia, March 1976.

9-4. Beeker, G. G., "Interface Control Document, NAS En Route Stage A -- ARTS-III," The MITRE Corporation, MTR-4114, Revision 3, McLean, Virginia, 1 October 1973.

9-5. O'Brien, W. J., "Terminal Information Processing System (TIPS): System Description," The MITRE Corporation, MTR-7161, Volume 1, McLean, Virginia, April 1976.

9-6. Hansen, J. C., et al., "FAA Communications System Description," Computer Sciences Corporation, AD-761 567, FAA-RD-73-36, Falls Church, Virginia, February 1973.

9-7. Federal Aviation Administration, "Specification -- National Airspace Data Interchange Network (NADIN)," FAA-E-2661, Washington, D.C., 4 January 1977.

9-8. Federal Aviation Administration, "Specification for the Flight Service Automation System, Volume I, System and Hardware," FAA-E-2683A, Washington, D.C., 7 August 1980.

9-9. Federal Aviation Administration, "Specification for the Flight Service Automation System, Volume II, Model 2 Software," FAA-E-2684A, Washington, D.C., 7 August 1980.

9-10. Federal Aviation Administration, "Specification for the Flight Service Automation System, Volume III, Model 1 Software and Hardware," FAA-E-2685A, Washington, D.C., 7 August 1980.

9-11. Federal Aviation Administration, "Engineering Requirements, Small Voice Switching System" FAA Document No. FAA-ER-220-052, 24 March 1977.

9-12. Federal Aviation Administration, "New Generation of VHF/UHF Air-Ground Communications Antennas," Washington, D.C., September 1977.

9-13. Federal Aviation Administration, "Engineering Requirement for Voice Switching and Control Systems," DRAFT FAA-ER-D-210-001, 30 June 1980.

APPENDIX B

ABBREVIATIONS AND ACRONYMS

AAAS	Automated Airport Advisory System
AAF	Airway Facilities Service
AAT	Air Traffic Service
ABDIS	Automated Service B Data Interchange System
ACD	Automatic Call Distribution
ACT	FAA Technical Center
ADWS	Air Force Digital Weather Service
AEM	Automated En Route Metering
AERA	Automated En Route Air Traffic Control
AFOS	Automation of Field Operations and Services
AFSS	Automated Flight Service Station
AFTN	Aeronautical Fixed Telecommunications Network
A/G	Air/Ground
A/G/A	Air to Ground to Air
AGL	Above Ground Level
AIRS	Airport Information Retrieval System
ALWOS	Automated Low-Cost Weather Observation Systems
ARD	Systems Research and Development Service
ARO	Airport Reservation Office
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ATARS	Automatic Traffic Advisory and Resolution Service
ATCBI	Air Traffic Control Beacon Interrogator
ATCCC	Air Traffic Control Command Center
ATCRBS	Air Traffic Control Radar Beacon System
ATIS	Automatic Terminal Information Service
ATS	Automated Terminal Services
AT&T	American Telephone and Telegraph Company
AUTOVON	Automatic Voice Network
AV-AWOS	Aviation Automated Weather Observation System
AWANS	Aviation Weather and NOTAM System
AWES	Aviation Weather System
AWP	Aviation Weather Processor
AWS	Air Weather Service
AWSS	Airborne Wind Shear System

BCAS	Beacon Collision Avoidance System
BRITE	Bright Radar Indicator Tower Equipment
BUEC	Back-Up Emergency Communications
CAL	Commercial Airlines
CARF	Central Altitude Reservation Function
CCC	Central Computer Complex
CCP	Contingency Command Post
CCTV	Closed Circuit Television
CD	Common Digitizer
CDC	Computer Display Channel
CED	Computer Entry Device
CFCF	Central Flow Control Function
CFCCC	Central Flow Control Computer Complex
CFWSU	Central Flow Weather Service Unit
CGATIS	Computer Generated Automatic Terminal Information System
CMA	Control Message Automation
CNS	Consolidated NOTAM System
CONUS	Conterminous United States
CRD	Computer Readout Device
CRT	Cathode Ray Tube
CS/T	Combined Station/Tower
CTA	Calculated Time of Arrival
CWPC	Center Weather Processing Complex
CWSU	Center Weather Service Unit
DABS	Discrete Address Beacon System
DARC	Direct Access Radar Channel
DCS	Data Communications Subsystem
DDD	Direct Distance Dialing
DEDS	Data Entry and Display Subsystem
DF	Direction Finder
DME	Distance Measuring Equipment
DR&A	Data Recording and Analysis
DTE	Data Terminal Equipment
DTG	Data Transmission Group
DUAT	Direct User Access Terminal
DYSIM	Dynamic Simulation
EBCDIC	Extended Binary Coded Decimal Interchange Code
E&D	Engineering and Development
EFAS	En Route Flight Advisory Service
EMSAW	En Route Minimum Safe Altitude Warning System
ETABS	Electronic Tabular Display Subsystem
ETIS	Enhanced Terminal Information Services
EWEDS	En Route Weather Display System

FAATC	FAA Technical Center
FAD	Fuel Advisory Departure
FAX	Facsimile
FDAD	Full Digital ARTS Display
FDC	Flight Data Center
FDEP	Flight Data Entry and Printout
FDIO	Flight Data Input Output Equipment
FDP	Flight Data Processing
F&E	Facilities and Equipment
FP	Flight Plan
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSH	Flight Service Hub
FSP	Flight Strip Printer
FSS	Flight Service Station
FTS	Federal Telecommunications System
FWS	Flight Watch Specialist
FX	Foreign Exchange
GA	General Aviation
G/G	Ground/Ground
GPI/GPO	General Purpose Input/Output
GPS	Global Positioning System
GOES	Geostationary Operational Environmental Satellite
HSP	High Speed Printer
HUD	Head Up Display
IAFCS	Interim Automated Flow Control System
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
IFM	Integrated Flow Management
IFR	Instrument Flight Rules
IFSS	International Flight Service Station
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IOCE	Input/Output Control Element
JAWOS	Joint Automated Weather Observation System
LASS	Line Automatic Sensing and Switching
LF	Low Frequency
LLWSAS	Low Level Wind Shear Alert System
LORAN	Long Range Navigation
LRCO	Limited Remote Communications Outlets
LSR	Limited Surveillance Radar
LX	Local Exchange

MAPS	Meteorological and Aeronautical Presentation System
MIL	Military
MLF	Medium Low Frequency
MLS	Microwave Landing System
MPS	Maintenance Processor System
M&S	Metering and Spacing
MSAW	Minimum Safe Altitude Warning
MTBF	Mean Time Between Failure
MTBR	Mean Time Between Repair
MTD	Moving Target Detector
MTI	Moving Target Indicator
NADIN	National Airspace Data Interchange Network
NAFAX	National Facsimile Circuit
NAFEC	National Aviation Facilities Experimental Center
NAS	National Airspace System
NASCOM	National Aviation Systems Communications
NASNET	National Airspace System Network
NATCOM	National Communications
NAVAID	Navigational Aid
NAVSTAR	Navigation System for Timing and Ranging
NDB	Nondirectional Beacon
NEXRAD	Next Generation Weather Radar
NESS	National Environmental Satellite Service
NFDC	National Flight Data Center
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NOTAM	Notice to Airmen
NWS	National Weather Service
OAG	Official Airline Guide
ORD	Operational Readiness Demonstration
OSEM	Office of Systems Engineering Management
OTC	Over the Counter
PAM	Peripheral Adapter Module
PATWAS	Pilot Automatic Telephone Weather Answering Service
PDME	Precision DME
PIREP	Pilot Weather Report
PTD	Proposed Time of Departure
PVD	Plan View Display
PWI	Proximity Warning Indicator
RBX	Radar Beacon Transponder
RCAG	Remote Center Air-Ground

RCO	Remote Communications Outlet
RCCS	Radio Communications and Control System
RCS	Radio Communications Subsystem
RDAS	Radar Data Acquisition System
RDF	Radio Direction Finder
RDP	Radar Data Processing
RML	Radar Microwave Link
RMMS	Remote Maintenance Monitor System
RMS	Remote Monitoring System
RNAV	Area Navigation
RRWDS	Radar Remote Weather Display System
R/T	Receiver/Transmitter
RTF	Radar Training Facility
RTQC	Real-Time Quality Control (of Radar)
RTR	Remote Transmitter/Receiver
RVR	Runway Visual Range
Rx	Receiver
SAC	Strategic Air Command
SAM	System Acquisition Management
SAR	Search and Rescue
SCC	(ATC) System Command Center
SFO	Single Frequency Outlet
SFSS	Satellite Field Service Station
SMMC	System Maintenance Monitoring Console
SRAP	Sensor Receiver and Processor
SRDS	Systems Research and Development Service
SS	Solid State
SRG	Systems Requirements Group
STC	Sensitivity Time Control
SVSS	Small Voice Switching System
SWL	Severe Weather Labs
TABG	Threshold Alpha Beta Gamma
TAC	Tactical Air Command
TACAN	Tactical Air Navigation
TAGS	Tower Automated Ground Surveillance System
TATF	Terminal Automation Test Facility
TCDD	Tower Cab Digital Display
TCS	Technical Control Subsystem
TDDS	Terminal Data Display System
TDP	Technical Data Package
TIDS	Terminal Information Display System
TRACAB	Terminal Radar Approach Control, Tower Cab
TRACON	Terminal Radar Approach Control, IFR Room
TRSB	Time Reference Scanning Beam

TSARC	Transportation Systems Acquisition Review Council
TS&S	Terminal Sequencing and Spacing
TTY	Teletypewriter
TWEB	Transcribed Weather Braodcast
Tx	Transmitter
UHF	Ultra High Frequency
VAS	Vortex Advisory System
VASI	Visual Approach Slope Indicator
VCS	Voice Communications Subsystem
VFR	Visual Flight Rules
VHF	Very High Frequency
VICON	Visual Confirmation of Voice Takeoff Clearance
VLF	Very Low Frequency
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnirange Station
VORTAC	Colocated VOR and TACAN
VRS	Voice Response System
VSCS	Voice Switching Control System
VT	Vacuum Tube
WBRR	Weather Bureau Remote Radar Recorder
WECO	Weatern Electric Company
WFMU	Weather and Fixed Map Unit
WMSC	Weather Message Switching Center
WSFO	Weather Service Forecast Office
WSR	Weather Service Radar
Wx	Weather

APPENDIX C

INDEX OF ATC SYSTEM IMPROVEMENTS

ARTS IIA	3.1.1.3
ARTS IIIA	3.1.1.2, 3.1.3.2
Air Traffic Control Command Center (ATCCC) Communications Processor	5.1.1.2
Advanced Vortex System (AVS)	4.1.4, 4.4
Air Route Surveillance Radar (ARSR-4)	7.1.1, 7.1.3
Air Route Surveillance Radar (ARSR) Weather Channel	7.1.3
Airborne Wind Shear System (AWSS)	4.1.2
Airport Surface Detection Equipment (ASDE -2, -3)	4.1.1, 4.1.3
Airport Surveillance Radar (ASR-9)	7.2.3, 7.3
Airport Surveillance Radar (ASR) Weather Channel	7.2.3
Applications Processor for DABS Data Link	2.1.1.4, 3.1.1.4
Automated Airport Advisory System (AAAS)	4.1.4
Automated En Route Air Traffic Control (AERA)	2.1.3.4
Automated Flight Service Station (AFSS)	6.
Automatic Traffic Advisory and Resolution Service (ATARS)	2.1.3.3, 2.1.4.3, 2.1.4.4 3.1.3.3, 3.1.4, 3.1.4.3, 7.2.3

Automatic Traffic Advisory and Resolution Service (ATARS) Avoidance Advisories	2.1.6.4, 3.1.6.3
Aviation Weather Processor (AWP)	6.1.3.1
Beacon Collision Avoidance System (BCAS)	2.1.4.2, 3.1.4, 3.1.4.2, 3.1.4.4
Center Weather Processing Complex (CWPC)	2.1.2.4
Center Weather Service Unit (CWSU)	2.1.2.1, 2.1.2.2, 2.1.2.3
Central Altitude Reservation Function (CARF)	5., 5.1.3
Central Flow Control Function (CFCF)	5., 5.1.1.1, 5.1.1.2, 5.1.1.3
Central Flow Weather Service Unit (CFWSU)	5.1.5
Cockpit Display of Traffic Information (CDTI)	8.1.2.5
Common Digitizer (CD-2)	7.1.1, 7.1.2
Computer Generated Automatic Terminal Information Service (CGATIS)	4.1.2
Computer Replacement, En Route ATC	2.1.1.4
Computer Replacement, Terminal ATC	3.1.1.4
Conflict Advisory Function, IFR/VFR	2.1.4.2
Conflict Resolution Advisory	2.1.4.2, 3.1.4
Contingency Command Post	5.1.4
Control Message Automation (CMA)	2.1.5.4, 3.1.5.3
Controller Sector Suite Improvements	2.1.2.4

Data Terminal Equipment (DTE) for the ATC Command Center	5.1.1.2
Direct Access Radar Channel (DARC)	2.1.1.1, 2.1.1.2, 2.1.1.4
Direction Finding Equipment Replacement	9.2.1.3
Discrete Address Beacon System (DABS)	2.1.3.3, 2.1.4.3, 2.1.4.4, 3.1.3.3, 3.1.4, 3.1.4.3, 7.2.3
Discrete Address Beacon System (DABS) Data Link	2.1.1.4, 2.1.5.4, 3.1.5.3 4.1.4, 9.1.1.1, 9.1.1.2
Display of Digital Data	3.1.2.3, 3.1.3.3
Electronic Tabular Display Subsystem (ETABS)	2.1.1.3, 2.1.2.3, 2.1.2.4
En Route Metering	2.1.7, 2.1.7.1, 2.1.7.2, 2.1.7.3
En Route Weather Display System (EWEDS)	2.1.2.2
Enhanced Terminal Information Service (ETIS)	3.1.5.3, 4.1.3
Expanded DABS/Data Link Communications	9.1.1.1, 9.1.1.2
Flight Data Input Output Equipment (FDIO)	2.1.2.2, 2.1.3.3, 3.1.2.2, 3.1.3.2, 4.1.2
Flight Service Data Processing System (FSDPS)	6.1.3.2
Flight Service Station - Model 1	
Digitized Weather Radar	6.2.9
Flight Plan Processing	6.1.1, 6.1.7
Weather and Aeronautical Information	6.1.3, 6.1.5, 6.1.6, 6.2.3, 6.2.4

Flight Service Station - Model 2	
Automated Flight Service Station	6.
Aviation Weather Processor (AWP)	6.1.3.1
Aviation Weather Processor (AWP)/ Weather Message Switching Center Consolidation	6.1.3.1, 6.2.3, 6.2.4
Consolidated FSS Model 2, Model 3	6, 6.1.10, 6.1.11, 6.1.13, 6.2.7
Direct User Access	6.1.10, 6.1.11
Emergency Assistance	6.1.1
Flight Service Data Processing System (FSDPS)	6.1.3.2
Graphics and Multiple Weather Radar	6.1.6, 6.2.9
Integrated Voice Response System	6.1.10, 6.1.11
Selective Weather Retrieval	6.1.6
Full Digital ARTS Display (FDAD)	3.1.2.3
Global Positioning System (GPS)	8.1.1, 8.4
Head Up Display (HUD)	8.1.2.5
Helicopter Operations, IFR	8.1.1
Improved Antennas for Air/Ground Sites	9.2.1.1, 9.2.1.2, 9.2.1.3
Integrated Flow Management	2.1.7.4, 3.1.7.4, 5.1.1.3
Joint Automatic Weather Observation System (JAWOS)	4.1.3
Limited Surveillance Radar (LSR)	7.2.4
Maintenance Processor Subsystem (MPS)	2.1.1.2, 9.2.1.1

Microwave Landing System (MLS)	8.1.2, 8.4
Moving Target Detector (MTD)	7.1.3, 7.2.3
National Airspace Data Interchange Network (NADIN)	9.1.2.2
Next Generation Weather Radar (NEXRAD)	4.1.3, 7.1.3, 7.2.3
Radar Beacon Transponder (RBX)	3.1.4.2, 7.2.2
Radar Remote Weather Display System (RRWDS)	2.1.2.2
Remote Maintenance Monitor System (RMMS)	2.1.1.2, 2.1.1.3, 2.1.1.4 7.1.3, 7.2.3, 8.1.1, 9.2.1.1
Runway Configuration Management System (RCMS)	4.1.4
Sensor Receiver and Processor (SRAP)	3.1.2.2
Solid State Transmitters and Receivers	9.2.1.1, 9.2.1.2, 9.2.1.3
TPX-42 Replacement	3.1.1.2
TRACON Weather Processing Function	3.1.3.4
Terminal Consolidation	3.1.1.4
Terminal Data Display System (TDDS)	4.1.2
Terminal Information Display System (TIDS)	2.1.3.3, 3.1.1.3, 3.1.3.3 4.1.3
Terminal Sequencing and Spacing (TS&S)	3.1.7.3
Terminal Weather Radar	4.1.4
Tower Automated Ground Surveillance (TAGS)	4.1.4
Tower Cab Digital Display (TCDD)	4.1.2

VOR and TACAN Station (VORTAC)	8.1.1, 8.4
Video Reconstitutors	3.1.2.3
Voice Switching and Control System (VSCS) - VF Signaling and Control System Replacement	9.2.1.1
Voice Switching and Control System (FSS)	9.2.1.3
Voice Switching and Control System (Terminal)	9.2.1.2
Voice Switching and Control System (En Route)	9.2.1.1
Voice Switching and Control System (Technical Control Subsystem)	9.2.2
Wind and Altimeter Voice Equipment (WAVE)	4.1.2
4D Navigation	8.1.1
9020 Replacement	2.1.1.4

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-729-472/2081

END

DATE
FILMED
10-81

DTIC